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THE GEOGRAPHICAL JOURNAL

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The
Geographical Journal.

No. 3. SEPTEMBER, 1907. Vol. XXX.

JOURNEYS IN NORTH MESOPOTAMIA.*

By MARK SYKES.

The region which I hope to make more familiar to the readers of this *Journal* is one that, although to-day but little known, was in former ages a closely contested frontier which occupied the attention of the world for a longer period, perhaps, than any other in history, and it is a zone which to-morrow may engross the whole attention of Europe —I refer to that region which the classicist might call Mesopotamia, and which Arabs, in the present as in the past, term the Jazirah, or Peninsula. The Arab name is significant and useful, and although for the base purpose of engaging attention I have planned that the title should mention that blessed and soothing alternative, now that I have entrapped the reader I propose to avoid it, and make use only of that used by the Arabs.

The name Peninsula, or Jazirah, takes its rise from the fact that the region in which we are interested is almost surrounded and cut off, as it were, by two great rivers—the Tigris and the Euphrates—for the lands which lie between them are generally known by that name.

The general physical features of the Jazirah are simple in the extreme, and it will not take long to make a brief survey of them. To the north we have a fairly continuous range of mountains stretching in an unbroken line from Jezire-ibn Omar to the western slopes of the Karaja Dagh (a mountain which I might say until lately was represented as a solitary and stately peak, but has on later maps subsided into several of a more probable and less singular shape). Beyond the western slopes of the Karaja Dagh there is an apparent hiatus in this highland limit, which is in reality only an easing of the rising

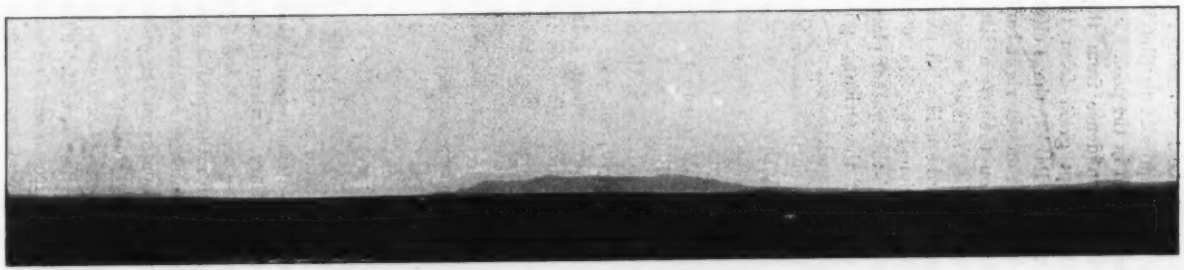
* Read at the Royal Geographical Society, March 11, 1907. Map, p. 356.

gradient from south to north, and is soon made good in the tumbled hills and mountains which stretch from Urfa to Birijik. This line of hill-country overlooks the lowlands of the Jazirah almost as the coast-line of a continent overlooks the ocean. In places, as between Mardin and Jezire-ibn Omar, the distinction is abrupt and decisive; the huge plains run up to the foot of the ascent, which at a distance of 10 or 12 miles suggests the likeness of an unbroken line of cliffs. The rising slopes of the Karaja Dagh group, on the other hand, merge gradually from the low country like some great island, and remind one faintly for a moment of a distant view of St. Vincent. The western continuation of the line, if we would follow the simile further, is much broken by bights, bays, and creeks, and presents a somewhat confused appearance.

The second great feature of the Jazirah to which I would draw attention is the line of the Sinjar and Jebel abd-ul Aziz—two mountains which, save for one depression, form a continuous range some 125 miles in length. The singularity of these two ranges lies in their peculiar wall-like formation; in no place, I think, is either of them above 10 miles in breadth, nor does either possess any striking peak or summit; and though their actual tops are seemingly serrated with unremarkable projections, yet the general impression conveyed to the eye of the traveller, whether he views them from the north or south, is that of a vast earthwork, or an entrenchment of gigantic dimensions.

Having now described the mountains, we will turn to the river system. As will be seen from the map, both the Tigris and the Euphrates have one peculiarity in common; in both cases their more important affluents reach them from their left banks, consequently the Jazirah contributes nothing to the Tigris and all to the Euphrates. The interior waters of the Jazirah may be divided into two sections—the first flowing from the direction of Urfa, and ultimately, by the Belikh, passing into the Euphrates at Rakka; and the second the great Khabur river, with its various feeders, which take their rise at the foot of the Karaja Dagh and along the Mardin hills. The Belikh is a very peculiar waterway, and the fact that it is within reach of two such large towns as Urfa and Aleppo makes the fact that it is almost entirely unexplored very strange indeed. It is a deep, narrow stream some 30 feet wide and about 8 feet deep, with a moderate current, and, speaking generally, soft spongy banks. It takes its rise in the vicinity of Harran, where there are a good many springs, but its principal source of supply is at 'Ain el Arus, a spring and pool situated amidst low rolling hills.

'Ain el Arus is a famous shrine, and is the legendary site of the marriage and wedding festivities of the Prophet Abraham. In the centre of the pool is an abundant spring, filled with an enormous quantity of carp and fresh-water turtles; these creatures, together with the waterfowl which haunt the place, are looked on as sacred, and are



N. ← → S.

PANORAMA TAKEN AT KESRUKH.

N. ← → S.

CONTINUATION-PANORAMA TAKEN AT KESRUKH.

quite tame. If a man desires any particular wish, he is counselled to pray in the little mosque at 'Ain el Arus, give a present to Shaykh Saleh, who has charge of the shrine, and feed the fish in the pool. The fish are so tame, and have acquired so much confidence from this practice of pilgrims, that they will actually accept grain from the hand of a stranger. Between 'Ain el Arus and Rakka, the Belikh receives the waters of two tributaries: the Karamuk on the right bank a little below Tel el Hamam, and the Suluyuk on the left a little further north. At Tel el Hamam I discovered the ruins of a castle and a gigantic cistern; these remains, I think, may be said with some certainty to be those of Kelat Maslamah, mentioned by Mr. Guy L'Estrange in his 'Lands of the Eastern Kaliphate;' that author places it on his map (compiled from the *written* works of the Oriental geographers) not above a mile from the place where I found the ruins.

Mr. L'Estrange also marks the town of Bajerwan on the left bank of the Belikh, between Hamam and Ragga, in precisely the same spot on which I found the ruins of an extensive city. The banks of the Belikh are extremely fertile, and barley, maize, dura, rice, hemp, and opium can be cultivated on them with great success. I am unable to supply such detailed information concerning the Khabur as the Belikh, as I have never ridden down it, but have only crossed it at Ras el Ain and Shedadeh. At Ras el Ain it is a fair river about 40 feet wide and 3 feet deep; at Shedadeh, however, it had grown far greater, being unfordable, and, I should say, almost of the same proportions as the Thames at Maidenhead. Between Ras el Ain and Shedadeh the Khabur receives the waters of the Jag-Jag and the Girgan rivers, both strong perennial streams along which cultivation is possible, and, from the numerous ruins which stud their banks, I should imagine would prove profitable.

We must now consider the large areas of plain which lie betwixt these mountains and rivers. I will take them from west to east. The first section is that which lies between the Euphrates and the Belikh; this is a stony region of bare and forbidding hills, arid, repulsive, and uninteresting. There is one brief season when it is attractive, and that is in early spring; the following extract from my diary, written in the month of March, may give an imperfect impression:—

"The next morning we set out into the desert, or rather prairie, for that cannot be called a desert which the slightest scratch is sufficient to cultivate, and where the pasture is green for two months in the year. The lands of the Jazirah, indeed, differ from any other rolling stretches of country I have ever seen, and bear not the faintest resemblance to either the Texan or Mexican plains, nor the South African veldt. The atmosphere, which is at once clear and hazy, produces a very curious illusion—a stone 800 yards away appears to be close at hand, while a mountain on the horizon which is not more than 6 miles away appears

to be treble the distance; the two effects combined give an impression of a vastness and space that it is difficult to describe in words. The sky, which in spring is often cloudy and overcast, throws strange streaky shadows over the landscape, and a dull indefinite line of grey on the horizon will change suddenly to a clear bright ridge of yellow hills, which is equally quickly transmuted to a dark, forbidding range of purple mountains; the wadies form trailing serpents of olive-green and brilliant flowers; the rolling steppes run in lines of grey and green, thus marking the good grazing-land from the stony tracts. On the sky-line herds of camels move almost imperceptibly to and fro cropping the grass, while on the hillsides dappled flocks of sheep speckle the country with

MOSQUE AT 'AIN EL ARUS.

splashes of black and brown and yellow. The larks, while in the air, sing cheerily. Now and again a rare thunderstorm comes rushing across the land—a dark curtain of black, from which the huge falling drops smite the dusty ground, the hills and distant plains vanish, the horizon closes in, the ground turns yellow and red, the yellow lightning sends an unearthly sheen upon the grass, and for ten minutes we are in a strange unknown world of rushing waters, roaring wind, and rolling thunder. The storm passes over, the camels and sheep begin to move again, the larks are once more in voice, and, save for a little brightness in the sky, the desert is as it was before."

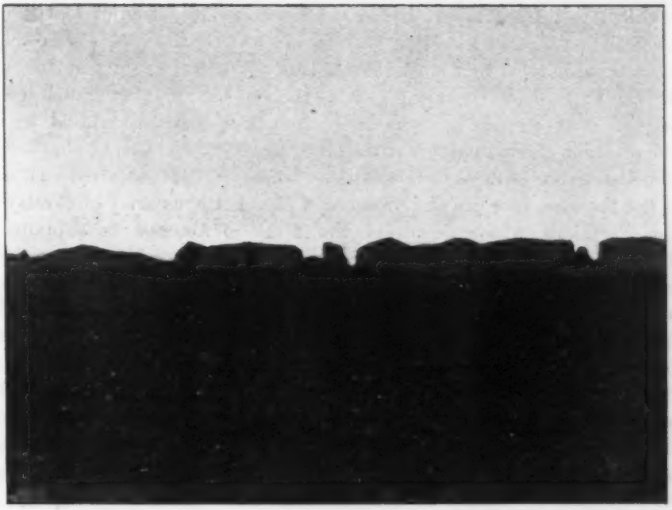
Once the line of the Belikh is reached, the scenery undergoes a

complete change; at all seasons the grass is green in its vicinity, and swamps and bogs are common. Between the Belikh and the Khabur we have another vast steppe of rolling hills, which, as one proceeds eastward, becomes more veldt-like and stony; the curious little conical hills, pimples as it were on the face of Nature, grow more frequent, and from convenient landmarks change into aggravating and perplexing distractions.

After crossing the Khabur we enter another and totally different description of the low country. From a land of low grassy wolds, where the view is always curtailed by a horizon of rolling undulations, we pass into a country where the visible distances are immense, and the natural features distinct and pronounced. Where we formerly looked eagerly for the sign of some slight hill or landmark, we stare blankly at the castle of Mardin, some 50 miles away, or at the snowy peaks of the Karaja Dagh, which hang, as it were, suspended in the air at nearly double that distance. Or if we turn south, the forbidding bulk of the Sinjar stands before us. Nor is it a flat and empty plain which is enclosed by these far-off barriers. Instead of empty wadis, we cross deep but narrow perennial streams, which thread their way through deep valleys, or alongside unending ranges of dark hills; while in place of the green grass we have grown so accustomed to, we ride over masses of flowers which dazzle the eye with their brilliancy and variegated colour, and whose honey scent is at times almost oppressive. I am sadly ignorant in botany, or I should attempt to give some account of them. As it is, I can only say that the hillsides are splashed with yellow, blue, and purple, while on the river-sides our horses could hardly force their way through the snowy banks of daisies and cowslips. And yet this well-watered country, whose fertility bursts out in this torrent of blossom, is almost uninhabited. As we proceed further east the magnificent and mysterious mountains of Kurdistan become visible, and the traveller finds himself in the centre of a vast horizon, of which this panorama gives some slight impression. The plain to the south of the Sinjar is another and wonderful change. Here we find an appalling flatness stretching mile upon mile, seemingly never destined to end.

Now, the question which naturally presents itself to one's mind is, What was the past of this strange and silent region? This is not the South African veldt with its miserable emptiness, or the Sahara with its dismal solitude; this land was once teeming with life and wealth, business and war. If we peer back into the darkest antiquity, we find a land densely peopled by a highly cultured race; mighty mounds still mark with permanence their fleeting sojourn, huge canals and dykes, some containing water even now, remain to show us where man once was. What was the precise nature of their civilization it would be almost impossible to say now; in a few years we may expect that archæological research will probably yield much minute but little general information

PIT AT TELL EL HAMAM (KALAT MASLAMAH).



WALLS OF RAKKA.

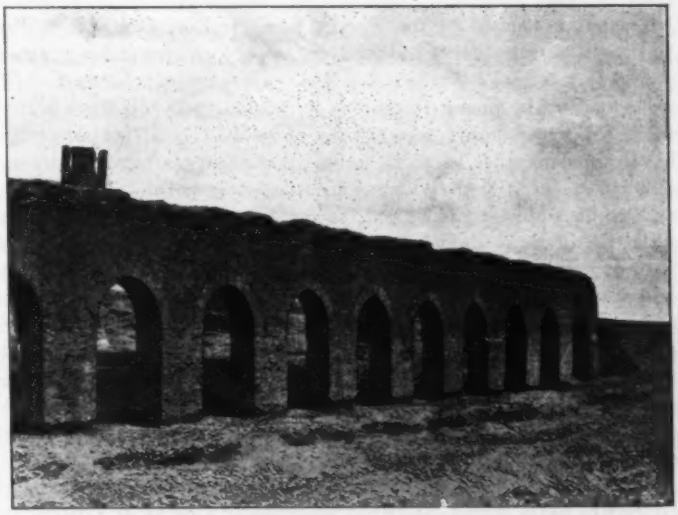
on that point; but this much we do know, that when Alexander appropriated the Persian Empire, the modern Jazirah contained many wealthy cities, that a large agricultural population flourished on the banks of the rivers to which I have just drawn attention, and, wonderfully enough, this prosperous population was never thoroughly disturbed amid all the changes of government and all the clashings and warrings that went on around it.

The empire of Alexander fades into Parthian and Seleucid dominion, the empires of the Macedonians are swallowed up into that of the great Republic, the dominion of the Parthians is changed to that of the Sassanian Persians, the Roman Empire of Augustus resolves itself into that of Constantine, and eventually the two ever-clashing forces of antiquity, Byzantium and Persis, are suddenly merged into one rule under the khalifs; yet through all these centuries and all these vicissitudes, read it as we will, the Jazirah seems to be ever the same. View it in the days of the triumvirate of Cæsar, Pompey, and Crassus. The rule for the nonce is Parthian, all along the Belikh there were great cities and isolated castles; along the Khabur the same; a fine town at Resaina, now Ras-al-Ain; in the north Nisibin and Dara, great flourishing and wealthy cities; Harran, a noted shrine enriched with costly gifts of devotees and worshippers; far to the south El Hadhr, another famous temple;—thus it always was along the rivers. And what of these great plains between them, dotted here and there, although it be but sparsely, with the remains of smaller towns? Personally, I am inclined to think, though if any one chooses to contradict I will not press the point, still I suggest that these great central plains were then, as now, inhabited by nomad shepherds. We know for certain that El Hadhr received its strength from the support of its affiliated desert tribes. May we not imagine, then, that these northern plains, where the tradition of Abraham * is still strong, were occupied also by shepherds, not wandering savages, but wealthy owners of the pastures? If this is not the case, how can the presence of the enormous army of cavalry of the Parthians which destroyed the army of Crassus be explained? How was it that during the winter the Romans could occupy such castles as they wished, and that, just as the pasture sprang up in spring, a huge army of cavalry suddenly congregated together, except by the fact that the shepherds deserted the middle plains in the winter and returned in spring as they do to this day?

It certainly suggests itself strongly to me that then, as now, the large plains between the rivers were occupied by a pastoral people, and that the river-banks only were settled. The presence of the ruins and mounds where there are springs of water and wells suggests that these

* Ain' el Arus and Hamam Ibrahim are still shrines of pilgrimage, and many Dervishes and holy men repair thither.

were either military stations, trading settlements,* wool depôts, and so on, whither the shepherds repaired to sell their produce and purchase commodities for themselves. Let us take a glance some three centuries later. Parthia is forgotten and dead; Persia is under the rule of Shapur; the Jazirah, which had been the battle-ground of East and West these three hundred years, seems, when Julian marched across it, to have been even as before. It was now practically entirely under Roman rule, and Julian and his army were able to march from Harran as far south as Rakka without needing a supply train, and when the broken army returned under Jovian from the south on the Tigris side, they found food and refreshment after passing the Sinjar in a land which is now



FACADE OF FRIDAY MOSQUE, RAKKA.

almost entirely empty. Another four centuries roll by. The Persian empire has breathed its last; that of Constantine, clipped and sheared of half its provinces, still survives; and the new power of the Moslems, the Eastern Khalifate, is in the full meridian of its glory at Baghdad.

Mr. Guy Lestrange, in a most admirable compilation, 'The Lands of the Eastern Caliphate,' gives a brief but striking account of the provinces of the Jazirah. Names have in many instances changed, whole cities have moved a league or so from their ancient sites, but the prosperity, the agriculture, the wealth, the teeming population remain. Then comes the rapid decline and disintegration of Arab dominion, and the commencement of the ruin of the prosperity of the Jazirah, long before

* Such as is Deir Zor to-day.

the Osmanli* power was heard of. Up to the present, although the Jazirah had almost continually formed a battle-ground, it had been the battle-ground of two great and wealthy empires, as Alexander and the Persians, the Seleucids of Antioch and their Eastern rivals, Rome and Parthia, Rome and Persia, Byzantium and the Caliphate. Consequently, no matter how the frontier had shifted, the land had always benefited to a certain extent from the advantage of having a government, whether European or Asiatic, which had the idea of extracting an income from the territory in question and no object in wasting it. However, in the twelfth century the whole aspect of affairs had entirely altered.

In 1174 we have a phantom khalif at Baghdad, independent kings of Mosul, Aleppo, Jezire-ibn Omar, Sinjar, and Erbil; while Edessa or Urfa, lately evacuated by the Franks, seems to have been left to look after itself—a collection of small incoherent and chaotic states governed by a motley array of Turkish and Arab adventurers, who continually raided and fought among themselves or wasted their substance in combating the never-ending wars of the crusades. It is not surprising that the opulent cities began to decline, that caravans became rarer and more infrequent, and the villages decreased in number. The country was ripe for a crushing blow, and Hulagu delivered it. The destruction of the Khalifate at Baghdad, the ruin of Syria by the Mongols, set the forces of rapid decline in motion; there was no imperial government to check, preserve, or save. Northern and Eastern Kurdistan, Irak, and Syria were all thrown into a state of hopeless and chaotic strife. The ancient canals were neglected, the people began apparently to migrate and flee, and Mesopotamia to assume its present appearance. The decline must have been slow but steady, for, as far as we can see, there was never any recrudescence of stable imperial power which is absolutely necessary for the development of prosperity in an Oriental country.

The small kingdoms and principalities jarred and jolted on through history like badly loaded, ill-driven waggons on a rough and dangerous road. Finally, we have the hideous vision of Timur sweeping in from the East. Such rags and tatters of wealth and cultivation as remained were now scattered by the armies of the destroyer, famine and massacre followed in his wake, and when, a couple of centuries later, the great Anatolian power of the Ottoman Empire reabsorbed the Jazirah into the Government of Byzantium, it was merely a pastoral tract that it annexed; and, indeed, the annexation was almost nominal, for even had the Turkish Government wished to administrate or improve the tracts they had wrested from Persia, they had neither the means nor the time. Victories, defeats, and politics on the western frontiers were then as great a hindrance to internal development as they are now. The

* I make note of this fact, because one is often led to suppose that the devastation and wreckage of centuries is entirely attributable to the tiny tribe of Osman.

question of how to find, pay, and equip an army for the conquest of Vienna affected the Asiatic provinces as keenly and as disastrously as do the ruthless and unscrupulous methods of the committeemen in Macedonia to-day. All that remained in the Jazirah were a few small towns at Rakka, Harran, Deir, Ana, Tell Afar, and Sinjar. Most of these were destroyed by the invasion of the Shammar Arabs, who broke in about that time and established Bedawin rule in the country and enslaved the surviving nomads.

I have now given a brief, imperfect, but general survey of the historic and physical aspect of the Jazirah; it now remains for me to give a more detailed view of its present condition. As in the past, the Jazirah is still a borderland—not a borderland between East and West, but a borderland between North and South; in fact, a borderland between the two elements in the population, which are respectively Arab and Kurd. In the Dersim mountains you will find the pure aboriginal and solitary Kurd, and in the desert you will find the Bedawin of the highest genealogy and the purest race. But between these two points you will find every variety of mixed people and a collection of tribes whose ethnological position is extremely confusing—a confusion which is rendered even more confounded when we come into touch with the Christian Jacobites of Tur Abdin and the devil worshippers of the Sinjar, for, owing to the Government system of grouping religions and sects into separate millets, and the efforts of the missionaries to introduce or foster among Christians what may be mistaken for a national spirit, we have a situation which for general complication and muddle is practically unrivalled.

The two great divisions are in fact the Arabs and the Kurds, the former predominating in the south, the latter in the north. The character of these two peoples is almost diametrically opposed, and is worth considerable attention. The pure Arab is a very strange being indeed. His mind is complex and cultured; there is no Arab of pure race to whom rhetoric, subtle argument, poetry, and histrionism do not appeal; he is able to take a broad view of matters, or to discuss reasonably on any subject within the range of his experience, and yet, when dealing with any material object, he seems almost a perverse dunderheaded clown. Work he loathes and abhors; his argumentative capacity provides him with an excuse; he announces that work is dishonourable and degrading. Consequently he avoids the point that he is incompetent, lazy, and incapable, and says that cultivating the ground, pitching a tent in a reasonable way, doctoring a horse, cooking food, building a house, are contemptible employments beneath the dignity of man, and leaves the baffled Western in the ridiculous position of a worthy but rather underbred person who has no finer instincts. However, although the Arab will not work, he has no scruples on the subject of money, before the attractiveness of which dignity, poetry, and the rest vanish like thin air.

The noblest and the basest Arabs are at one on this subject, to obtain as quickly as possible all the available cash they can lay their hands on being considered by no means degrading. But even here subtle dialectic comes into play; the Arab must always have right on his side, for in studied and complex hypocrisy they have nothing to learn from us. If an Arab would rob his guest—I am speaking from personal experience—he will first talk at length on the subject of honour, hospitality, and so forth; he will gradually work the matter round as to why you are travelling, throw out suggestions that spies, enemies, and intruders cannot claim hospitality, suggest that he himself is poor, question himself as to whether he ought not to detain you as a prisoner, again state that he is in want, and thus shift from blackmail to cajolery, and from gentle requests to threats, until he has extorted a sum of money which, in his curious brain, he might describe as the least he could accept with honour, or the most he could extract without danger to himself.

Another point in the Arab's character is his intense dislike of bloodshed and savagery; the tribes of the Jazirah are continually at war, and, as I have had plenty of evidence to the contrary, I think it would be absurd to accuse them of cowardice; but no one who has seen them or talked to them can fail to be struck with their extraordinary lack of vindictiveness, and their wonderfully merciful way of fighting. An Arab never fights to kill; his objects are to capture, to incapacitate, or to frighten into submission. He will, it is true, do a great amount of material damage—burn villages and ruin crops—but he will never take a life unnecessarily or refuse quarter, and never, as far as I know, beat or ill use a prisoner. On the other hand, a desert Arab will rob and tyrannize over his weaker neighbours in a peculiarly ruthless way, and always do his best to make agriculture impossible. And lastly, the great point in the Arab's mental attitude is pride and aristocratic prejudice; the Arab is proud of his own blood, and of his mare's blood for its own sake. He will show you a broken-down little crock, and inform you, with perfect truth, that she is of the best blood in the Jazirah; he will also show a fine stallion of his own, and tell you he is a "g'dish," or underbred animal; and there is no doubt it is the bad thoroughbred he admires and prefers to the finest-made cross-breed. As regards his shaykh and tribal leader, he discriminates in an equal degree between the clever warrior, astute diplomatist, and good business man of low extraction and the shaykh of high lineage, who may be a miserable epileptical creature, and always to the disadvantage of the low-born man.

Having given you something of the character of the Jazirah Arabs, we must now turn to their condition and distribution. The Arabs may be divided roughly into two kinds—those who work a little, and those who do nothing at all. The latter are the great shepherd tribes of the Anazeh, Shammar, Adwan, and Tai.* The Tai are a great Bedawi tribe who

* A few of the Tai do do a certain amount of agricultural work.

have been in the Jazirah for countless generations, and, indeed, they are supposed to have migrated northward long before the days of Mohamed. The Shammar, who form the bulk of the Bedawi population, are the descendants of a great invasion which took place some two hundred years ago, and now occupy the greater portion of the pastures between the Khabur and the Tigris south of the Sinjar; while the Anazeh, who are permanently installed on the left bank of the Euphrates above Rakka, have migrated thither within the last few years, chiefly, I think, on account of the great development of agriculture in North Syria. The Adwan, who are a subtribe of the Anazeh, seem to have drifted northward in the wake of the Shammar invasion. The condition of life among these nomads is equally simple whether they be rich or poor. Their wealth consists entirely in sheep and camels, and their only business is to drive their herds from place to place in search of pasture; in winter the tendency is northward, and in summer and autumn towards the south; but there are really no fixed rules, and springs and water-holes are so abundant that they are seldom much pressed to find new camping-grounds. The serious business of their life is in keeping up the regular and endless warfare in which they are continually engaged with one another. Their method of fighting is almost entirely confined to the use of the lance, which is carried javelin-wise,* the lance itself being a light bamboo some 18 to 20 feet in length, with a long knife-like head. Their tactics consist in a band of horsemen, from two to three hundred in number, swooping down on the herds of the enemy, some driving off succour, while others carry away the booty. The defence of the herds against these attacks is similar—a swift pursuit and an endeavour to draw off the marauders being the usual method. However, generally the advantage lies with the attacking force, as the defenders usually look to recouping themselves by a similar attack rather than to recapturing the lost herds immediately. In this, again, we may notice a peculiar Arab trait of character, for the reason is that the marauding party, if hard pressed, might hustle the captured animals unduly, and so render them almost worthless.

The rules of war in the Jazirah are as strictly and decently observed among Arabs as by the white and red Knights in 'Alice in Wonderland.' To kill an enemy in battle is discreditable and savage; to wound slightly is what is aimed at, and to wound a man slightly with a bamboo lance 20 feet long is no small feat of skill. To surrender is not discreditable; flight is as justifiable as attack; to carry on warfare at night would be scandalous and shameful, or, if we choose to take a cynical view, productive of inconvenient reprisals. Camps, as far as I could ascertain, are practically out of bounds for a similar reason. It will be seen, therefore, that warfare in the Jazirah is an elaborate form of sport, and

* That is to say, with the thumb towards the shoulder and the middle joints of the fingers upward, the lance being held over the shoulder.

I might add that one small view I had of the action of a marauding party convinced me that it was a sport which, for excitement, pure undiluted fun, suspense, and delight, left fox-hunting as far behind as fox-hunting might be said to outdistance lawn tennis; and for this reason, I think, although Bedawin of the Jazirah care little for the chase and are rather poor horsemen, they may be said to be the finest sportsmen in the world. I have yet to hear a Bedawi speak ill of his enemy, even though he may have had the worst of it himself; indeed, as far as I could see, there was as little personal animus between hereditary foes as exists between two elevens of our cricketers. Of course at times regrettable things are done, but the occasions are very rare indeed; the only really discreditable aspect of the intertribal warfare is the ruthless way in which the Bedawin of the shepherd tribes plunder the poor agriculture dependents of their antagonists, who, having neither arms nor horses, are incapable of defence and afforded little by their patrons.

It is now my duty to draw your attention to the condition of the agricultural Arab tribes, the Weldi, the Baggara, the Aghedaat, the Jibbur, and the Afadileh. These people, who dwell in tents similar to the Bedawin, are branded with the ignoble name of fellahin, which signifies that they have sunk so low as to work with their hands. Indeed, they do it very badly, but still the contamination of manual labour places them on a lower plane in the eyes of the desert Arab. In character, save that they are more hospitable and civil to strangers, they are the exact counterpart of their brethren the shepherds, many of them are of equally noble blood, and alliance with their women is not deemed dishonourable by the noblest. Their wealth or poverty depends partly on the crops of maize and doura and barley which they cultivate on the river-banks, and partly on their herds of buffaloes, which, as the latter cannot leave the banks of the rivers, are fairly safe from raids. Except the Jibbur, these agricultural tribes live in subjection to their neighbours of the desert, to whom they used to pay a tribute, which all agree was far more severe than the tax the Government now levies. However, although the Government extends a certain amount of protection to them, and often recovers looted stock, it cannot as yet guarantee them immunity from continual annoyance and discomfort, and of late many of the Baggara have abandoned cultivation on the banks of the Khabur and have taken to regular herdsmanship. It must also be noted that these agricultural tribes have, in common with many of the Arabs of Syria, the habit of leaving a great portion of the work to the women, and it is no uncommon thing to see a woman with a child on her back either ploughing or digging a canal while her husband dozes in the tent and the boys tend the herds of buffaloes. Notwithstanding their idleness, these Arabs are by no means intellectually stupid; all are imbued with the idea that the advent of the railway will mean great wealth and happiness for them, but have, since the rumours of the Euphrates valley

line first reached their ears in the fifties, grown rather sceptical. It is also my private opinion that the love of money, which is so strong in them, will prompt them to do harder work than they now will undertake. My reason is, that at present the only recompense for labour is personal comfort, for which the Jazirah Arabs have no apparent desire; indeed, their natural frugality is extraordinary. A little boiled rice or wheat, the roughest bread, some dates dipped in butter, or the flesh of a sick sheep or goat that has had to be killed, are their only foods, and this in spite of the fact that greater luxuries are well within their reach.

Having now described the Arabs, I will turn to the Kurds; but before going further, I must say that the Kurds are a very little

ARAB OF SOUTHERN SHAMMAR.

understood people, whose history has yet to be written, and even whose distribution is at present but little known. As regards their general distribution over the Ottoman Empire, and their divisions and racial differences, I must refer such as are interested in the matter to the memorandum I have appended to this paper.* Let it suffice to say that the opinions I express now only refer to those Kurds who inhabit the regions at present under discussion, and do not include the Kurds of Anatolia, the Pagans and Shias of the Dersim, the Zazas north of Diabekir, the Zilan Kurds north of Lake Van, the Kizilbash between Erzerum and Erzinjian, the Baba Kurds of the South Persian border, the Kochkiri branch, and various isolated settlements which

* This will be issued separately as an Extra Publication.

exist in other parts of the empire. Let it suffice to say here that the Kurds who live in the area with which we are now dealing are of four fairly distinct kinds: those who dwell on the southern slopes of the Karaja Dagh who belong to the Milli confederation, the Zazas and Karagech who inhabit the district round Severek and encumber the plains between Diarbekir and the Tur Abdin, and the mixed peoples of the Tur Abdin and the Yezidis of the Sinjar. If it were possible to imagine two colours more distinct than black and white, it would be possible to imagine two characters more widely differing than that of the Arab and Kurd. The pure Kurd is the most unsophisticated and gullible person in the world so long as you keep away from the material issues; his respect for a man who can read and write is almost pitiable; his nature is entirely averse to philosophical speculation of any sort or kind, his difficulty in following an intellectual argument painful, but his raw pawky appreciation of practical facts and material things almost Yorkshire in its directness. Indeed, to me the Kurd has much more of what I would term a Western type of mind, albeit undeveloped, in contradistinction to that which we would associate with the Oriental. I think nothing can make my meaning clearer than the relation of the following circumstance On my way home I had the good fortune to read 'Puck of Pook's Hill.' My wife, who accompanied me on the greater part of my journey, immediately drew my attention to the remarkable similarity which existed between the character of the old knight and several Kurdish chieftains of our acquaintance; and, indeed, the resemblance is extraordinary. If Mr. Kipling had named the knight Abdo Agha, and had dressed him suitably, I assure you you could not have a more correct portrait of a modern Kurdish nobleman.

The Kurds are, on the whole, blunt and somewhat uncouth, silent, and quite incapable of falsehood. If they do wrong—and they often do—they admit the fault in the simplest and most unaffected way. I had a muleteer who was honest, civil, and incorrigibly idle. "Did you ever kill a man?" I asked him one day. "Yes; sixteen on the Khazat road when I was a deserter from the army," came the reply in a voice absolutely unmoved. "You were a robber?" "Yes; but now, praise be to God, I am married and a muleteer." Another salient trait in the Kurdish character is generosity as regards money and lavish hospitality. With the Kurds hospitality is not an excuse for pompous empty boasting, as with Arabs; it is real. The guest is given of the best that can be found, whether he be rich or poor, and recompense is not looked for either in money or in presents. Among some Oriental peoples, for instance the Druses, a noble will not accept anything, but expects you to tip his servants heavily, and I have a suspicion that he sometimes shares in the plunder after your departure; but with the Kurds the following instance will be indicative of the general feeling. We were

travelling through a district among a tribe actually at war with the Government, and halted for lunch in a miserably poor village. Although we had food with us, and it was the month of Ramazan, the chief insisted on our partaking of his hospitality, and the village had to be ransacked to find something presentable. After we had eaten, I gave one of the retainers a small sum of money. Shortly after my host discovered the fact; he snatched the money out of the man's hand, threw it down, and trod upon it, and it was only after considerable difficulty and many apologies that I managed to pacify him. This extreme niceness only, however, obtains where the people are living under a tribal chief. Where they are working as ordinary peasants, money is not only accepted, but looked for; but they are hardly ever exorbitant in their demands, and never clamour after the manner of Anatolian Moslems, Armenians, or Arabs. Another peculiarity of the Kurd is his curious shame of his origin. A Kurd Agha, as a rule, will try to explain to you that he is of Arabian extraction, and that only his people are Kurds. There is, I believe, an Arab proverb which says, "The mule said my uncle was a horse." Certainly the Kurd has a similar feeling. If he commits a crime, he will say, "But I am only a Kurd, I know no better." Or if you ask a Kurd some religious question, he may answer, "I am no better than an animal, I know nothing."

The Kurds are also often peculiarly ruthless in their violation, or at least non-observance, of the convenient laws of war. To them the person of an ambassador and a guest is not absolutely sacred if he also happen to be a serious enemy. For instance, I recollect the case of two tribes who had been at war for some time. The chief of one of the tribes felt that unless he made peace his tribe would be ruined; he accordingly went to the tents of his enemies to treat for peace. They gave him food, but did not eat with him. They then told him that they had discussed the matter, and ordered him to say his "fatiha," or profession of faith; while he was doing so they shot him dead. Save for some particular exceptions which I shall immediately refer to, the Kurds are extremely industrious, and well aware of the advantages of material progress; their tents are comfortable, water-tight, and well pitched. The sedentary tribes are very hard working, builders of good houses, and I know of many districts where they are far better husbandmen than the Armenians. The Kurd, of course, will, as a rule, rely on a Christian performing manual labour for him; but, as a matter of fact, where there are no Christians to employ, the Kurd does far better work than a Christian would do for him, whether in carpet-making, ironwork, or agriculture.* There is also one other Kurdish custom, which I think is the occasion of many of their virtues, and that is their

* Those who doubt the accuracy of this statement, I refer for agriculture to the districts south of Giaver; for ironwork, to Sulemanieh; and for carpets, to the Dersim.

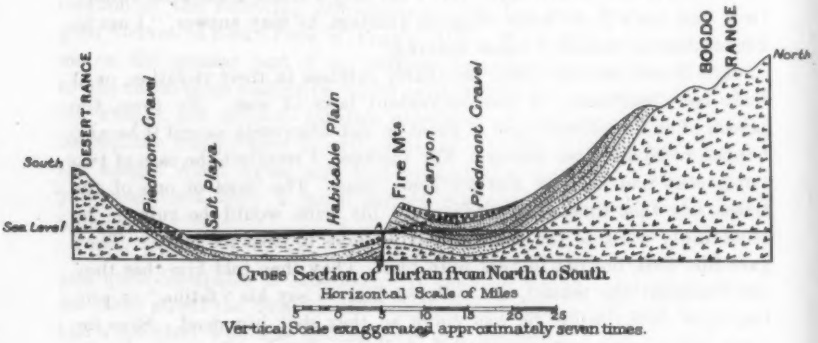
treatment of women. They neither veil them nor impose upon them heavy manual labour. Their women are well clothed, and are free to ride abroad, bully their husbands, and express their opinion in public affairs with as loud a voice as any suffragette could desire. To see a woman of sixty upright as a lance and with a good figure is not uncommon, and that, I think, is a sufficiently striking testimony to any one acquainted with the East.

(*To be continued.*)

THE DEPRESSION OF TURFAN, IN CENTRAL ASIA.

By ELLSWORTH HUNTINGTON.

The little basin of Turfan in Chinese Turkestan is of peculiar interest, because, though situated in the very heart of Asia, its lowest portion lies below sea-level. Various travellers have passed through it, and for more than a year it was the headquarters of a Russian scientific expedition. Recently it has been the scene of important archæological



Cross Section of Turfan from North to South.
Horizontal Scale of Miles
5 0 5 10 15 20 25
Vertical Scale exaggerated approximately seven times.

investigations by Grunwedel and Le Coq. The name Turfan is becoming well known; but, so far as I am aware, no one has hitherto published any adequate description of the region from a geographical point of view. The basin of Turfan furnishes an unusually good example of the geographical type characteristic of the arid regions of the world. *Physiographically* it consists of a ring of high mountains surrounding a smooth plain of sediments derived therefrom. The climate is so dry that most of the streams wither to nothing on the basin floor, while the rest terminate in an evanescent salt lake or playa. *Geographically*, the chief features are, first, that the dry climate almost inhibits the growth of vegetation in most places, but causes it to grow luxuriantly in the areas which are watered by the mountain streams; and second, that

man, being able to subsist only in a few limited oases where alone water is found, has developed the form of civilization characteristic of arid regions where irrigation is practised.

Upon reaching Turfan at the end of February, 1906, on my way northward to Siberia from the hitherto unexplored salt desert east of Lob Nor, I was at once impressed by the resemblance of the basin to Persia and other arid regions far to the west. At Doksun, or "Ninety," the first town, the days were so warm that the most pleasant place to sit at noon was on the flat roofs of the mud houses, although the night temperature fell to zero. As I looked abroad one noon over an ornamental parapet of sun-dried brick, a dreamy haze softened but did not blur the rounded outline of the pale blue desert mountains to the south. Far to the north and west the snowy tops of the higher peaks of the Bogdo range, rising 12,000 or 14,000 feet, gleamed fitfully among wisps of cloud. At their foot broad naked slopes of gravel were broken by descending lines of little mounds, the heaps of earth around the mouths of the wells by which the "kariz," or underground canals, are entered and cleaned. Nearer at hand the adobe walls of ruined forts or Buddhist shrines stood white and clear in the bright sunshine, while around them stretched a smooth yellow plain, where the reeds were all dead and broken off even with the ground. Nearest of all, four or five Chantos, or Mohammedans of Aryan race, in sober snuff-coloured gowns, and two women, in picturesque red jackets worn over blue skirts reaching to the knee, were spreading manure on grey fields. Two other Chantos in the same field ploughed up the grey soil with wooden ox-ploughs like those used from time immemorial all over Asia. A Chinese merchant, clad in pale blue, walked across the field toward the walled enclosure of the Chinese town; a high covered cart set on a long axle between two big cogged wheels, lumbered by, with one horse in the shafts and three abreast in front, and as it creaked between the high mud walls protecting precious orchards, the lolling driver encouraged his team with shouts of "Owa, owa, owa, *oh!*" and a wave of his fish-pole whip. Suddenly not only the distant scene, but the pale grey, almost dazzling prospect of neighbouring walls and fields was swallowed up in dust. A strong north-west wind had sprung up. Soon it increased to a gale, and I had to leave the roof to two gourds rolling merrily amid clouds of blinding dust. By sitting low on the warm mud oven filling half my room, I could have obtained light enough for my work, if the room had not been darkened by the heads of a dozen or twenty Dungans, or Mohammedans of Chinese race, whose eyes were glued to holes torn or sucked in the paper windows.

That evening, as my Chanto host was entertaining me by playing on a marvellously slender, long-necked tambourine, he remarked, "This wind is nothing. You just wait."

Two days later we were camped in the reedy salt plain 20 miles to

the east, beside a stone wall made of blocks of rock-salt. An evening gale came up, and blew over my tent and that of the men.

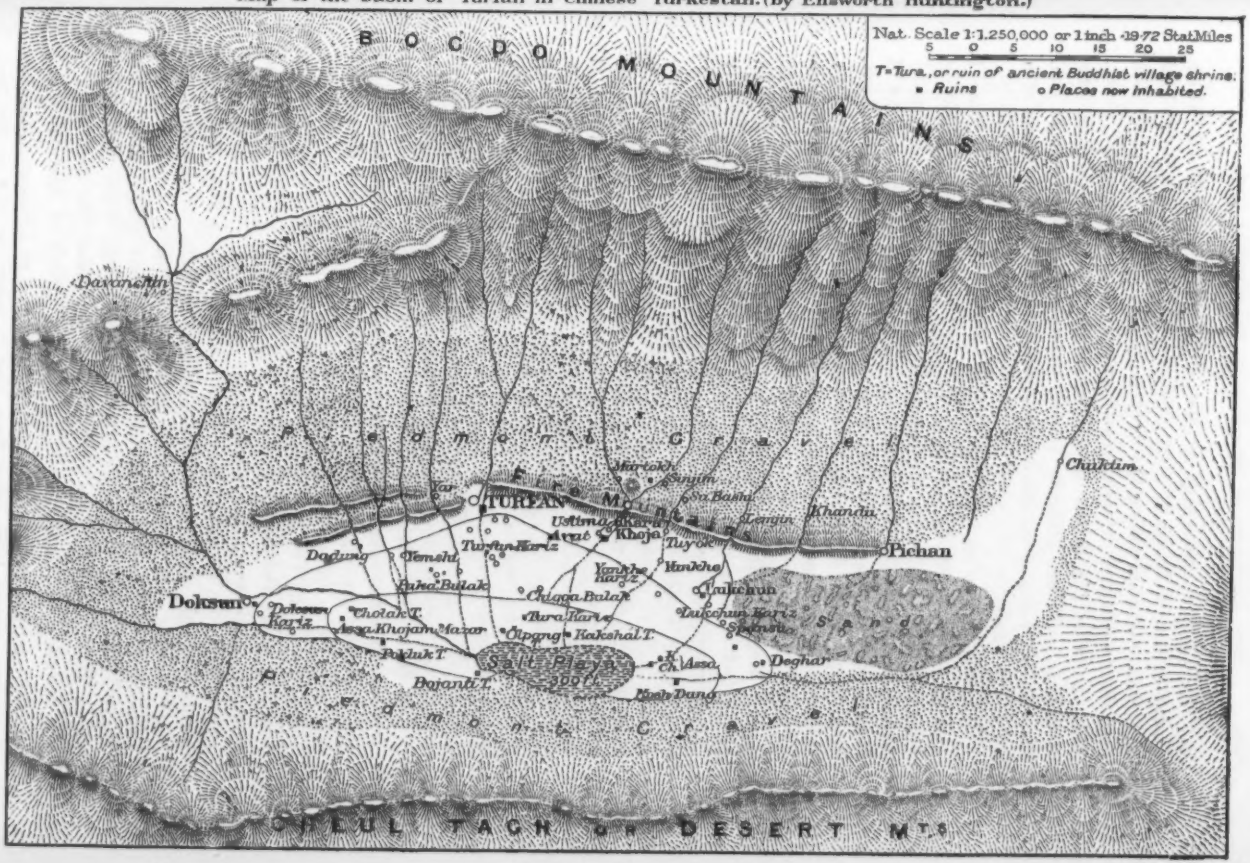
"This is nothing," said the host, who had become our guide. "Just wait till April or May. Then the wind takes the roofs off houses, and leaves the young wheat with 2 or 3 inches of its roots swept bare of earth. All this wind comes from a little lake on the way to Urumchi. There is an iron gate in the lake, and it is only half shut. If any one could shut it, the wind would stop."

I visited the lake on the way to Urumchi—the seat of the Chinese viceroy of the "new province"—100 miles north-west of Turfan, and saw the reason of the legend. Two monoliths, about 7 feet high, stand near the shore. Near them there are a number of artificial mounds of various sizes, and several lines composed of groups of stones. Each group consisted originally of about eight boulders from 1 to 3 feet in diameter, arranged in a circle perhaps 6 feet across. The whole aspect of these relics of an unknown race is almost identical with that of the mounds which I saw in 1903 with Prof. Davis, of Harvard, at Son Kul and Issik Kul, 600 miles to the west.

The climate of Turfan is characterized by extremes in other respects as well as in its winds. On March 5, a quiet sunny day, the temperature was 2° below zero Fahrenheit at sunrise, but rose to 54° above zero at noon in the shade of a high cliff. The summer in this mid-continental basin is of necessity very hot, as might be expected in a place 300 feet below sea-level. Horses, cows, sheep, and camels die unless driven to the mountains. Only the hardy donkey can live through many seasons. In 1894, when a Russian expedition spent a year at Lukchun, on the east side of the basin, the mean temperature of June and August was 87° Fahr., and of July 91°, and the absolute maximum 118°. Such temperatures as those of Turfan render exertion of every kind almost impossible in summer, but they make the fruits of the region most luscious. At the beginning of March I found fresh melons, grapes, apples, and pears in the markets, all of them most delicious and perfectly preserved. The only exception was a kind of pear which is never sold until it is rotted, as the flavour is then supposed to be best. In summer the variety of fruits is, of course, greater. The heat is so intense that melons are cut into strips and dried in the sun. In most parts of the world they would rot long before they became dry.

According to the Chinese, the summer is so hot that during the day the birds all gather in the shade of the trees beside the rivers. If one of them flies up he is scorched to a cinder, and falls sizzling into the water. Another Chinese yarn affirms that the heat is so great that after blowing on your rice to cool it, you must ply your chop-sticks as fast as possible. If you do not, the rice will become hot again and burn you. In winter, as might be expected, Turfan is cold. The mean temperature in January, 1894, was 15°, and the minimum

Map of the basin of Turfan in Chinese Turkestan. (by Ellsworth Huntington.)



−5° Fahr., which seems high in view of the temperature of −2° which I experienced on March 2, 1906. Snow never falls; at least, my host at Doksun said that during the forty years of his life he had never seen any there, although it falls yearly on the mountains round about. Rain, he added, is almost equally rare. Once or twice each summer it falls in sufficient quantity to wet the ground, though not to run. Once in ten years or so there is a cloud-burst, and raging floods ruin fields and houses.

In order to see as much of Turfan as possible in a short time, I planned to go around the periphery of the basin with horses, sending my camels to the capital, also called Turfan, to be sold. It proved impossible to carry out this plan entirely, because south of the playa of Böjanti there is no water. When we tried to go north of the playa, there was so much water that three horses sank into the mud so deeply that we were obliged to unload them before they could extricate themselves. At Deghar, the most eastern village which I visited, we found a queer anomaly. Although the village lies in an almost rainless region at the foot of some of the highest sand-dunes in the world, it not only has suffered from occasional floods, but the houses have to be rebuilt every five years because they sink into the mud. The plain of Turfan is so flat that in spring underground water from the mountains converts hundreds of square miles into impassable muck. It might be expected that plants would grow abundantly, as in the zone of vegetation of the great Lob basin to the south. So they do, to a certain extent, and have done much more extensively in the past. On the whole, however, the water dries up so early in the season that only camel-thorn and a few reeds can flourish.

The chief physical features of Turfan, aside from its arid climate and strong north-west winds, are illustrated in the accompanying map and section. As is usual in the enclosed basins of arid regions, there are four chief divisions arranged concentrically, namely, the mountains, the Piedmont gravels, the habitable plain of fine soil, and the central lake or playa. The crests of the peripheral ring of mountains form the boundaries of the Turfan drainage area, measuring about 80 miles from north to south, and nearly 200 from east to west. On the north and west the Bogdo and other ranges of the eastern part of the Tian Shan system rise to a height of from 12,000 to 14,000 feet, and, being comparatively well supplied with rain and snow, form the source of the chief streams. In most places the lofty mountains are difficult to traverse, so the roads must follow deep, precipitous gorges; but in the neighbourhood of Davanchin, near the Lake of the Winds, mentioned above, there is a pass only 3700 or 3800 feet above the sea. This is the lowest point in the whole of the vast circuit of mountains and plateaux which hem in the great basin region of Chinese Turkestan, extending nearly 1500 miles from east to west and 500 or 600 from

north to south. Wright* has recently stated that "all through Tertiary times" this pass served as a connecting channel between the Arctic ocean, which then covered Siberia, and a great interior sea in Western and Central China. He further holds that since man has occupied the Earth there has occurred a brief submergence by which the whole of Northern and Central Asia was covered by the ocean at the time of the Noachian deluge, and the pass near Davanchin was converted into a strait connecting an inner and an outer sea, as the Strait of Gibraltar connects the Mediterranean and the Atlantic. The theory is most interesting; but I found absolutely no evidence to

A VALLEY IN THE CHOL TAGH, OR DESERT MOUNTAINS, SOUTH OF TURFAN. ICE IN THE FOREGROUND.

support it. Central Asia does not appear to have been covered by the ocean since Eocene times, at the beginning of the Tertiary era millions of years ago.

In contrast to the lofty mountains on the north and west sides of Turfan, those to the south are low, with well-rounded, mature forms. They are intensely dry, and well deserve the name of Cheul Tagh—the Desert mountains. The few springs are usually saline, and there are no perennial streams. Nevertheless, during periods of occasional rainfall they are areas of rapid erosion, like all the other mountains.

The other three concentric divisions of Turfan are areas of deposition.

* 'Scientific Confirmations of Old Testament History' (Oberlin, Ohio, 1906), pp. 214, 302, 309–312, 321.

The coarser waste carried by floods is deposited at the base of the mountains as a zone of Piedmont gravel. In the course of ages the gravel has gradually accumulated to great depths, burying the lower slopes of the mountains, and forming a broad barren expanse like a beach of shingle from 5 to 20 miles wide. In its dry porous depths most of the streams, even those from the highest mountains, gradually lose themselves, disappearing completely. At the inner edge of the zone of Piedmont gravel—that is, at the edge farthest removed from the mountains—pebbles give place to fine clayey deposits forming a smooth plain. The plain is covered with reeds and camel-thorn, half of which are dead. Villages dot it here and there where water can be procured for irrigation. As one approaches the centre of the basin, the plain becomes more or less saline, and the clumps of trees characteristic of villages give place to grey towers of adobe, marking sites once occupied by man, but now no longer habitable for lack of water. Finally, in the lowest part of Turfan, 300 feet below sea-level, the saline plain gives place to a still more saline playa, the central reservoir toward which flow all the centripetal streams from the mountains, though only the one from Davanchin is able to reach it for more than a few days at a time.

The peripheral upland, the Piedmont gravel zone, the inhabited plain of fine soil, and the salt lake or playa fed by withering centripetal streams,—all these are typical features of the basins of arid regions. Two features of Turfan, however, are peculiar: the vast accumulations of sand at the eastern end of the plain, and the little range of the Fire mountains on its northern border. The sand has been taken from the plain and from the gravel zone by the prevailing north-west gales, and has been piled into enormous dunes 500 or 600 feet high. It is dark in colour, because the mountains from which it was originally derived are composed largely of basaltic lava. It forms an absolutely desert region, into the centre of which the natives never penetrate, so far as I could ascertain. They speak of the "Sand mountains" as an unknown region into which they dare not venture far, the home of goblins and demons dwelling in ruined cities which were buried in sand because of the gross immorality of the inhabitants.

The Fire mountains are not volcanic, although their name has given rise to the oft-repeated fiction that an active volcano exists in Central Asia. There is nothing of the sort. The name was given to them by the Chinese because of the brick-red colour of the sandstone of which they are composed. The sandstone is largely of Tertiary age, but part of it perhaps dates back as far as the Cretaceous. It varies from very coarse to very fine in texture, and is often interrupted by bands of light-coloured clayey shale or of gypsum. Everywhere it is full of ripple-marks, raindrop prints, mud cracks, and the like. These features, together with the absence of fossils, the inconstancy of individual

layers, and the prevailing red colour, show that the strata were deposited sub-aërially, and that the Turfan basin has not been submerged beneath the sea during recent geological times. They also prove that throughout the Tertiary period the climate was, for the most part, as dry as it now is.

The structure of the Fire mountains will be readily understood from the cross-section on p. 254. At a very recent date, geologically speaking, a fault or dislocation (A–B in the cross-section) took place along an east-and-west line parallel to the Bogdo range and about 40 miles from the main crest. North of the fault a long narrow strip of the Earth's crust about 5 miles wide was uplifted and tilted so that it dipped northward. To the south the plain of fine soil dropped to a lower level, and the

YOUNG MEN OF TURFAN DIGGING THE STALKS OF REEDS WHICH DIED CENTURIES AGO AND ARE NOW TO BE USED AS FUEL. THE FEATHERY WEEDS ARE CAMEL-THORN.

front of the tilted strip was left as a steep, inaccessible red escarpment about 2000 feet high. At its western end, beyond the low place in the mountains where, as the map shows, Turfan is located, the fault splits into two parts, giving rise to two steep southward-facing escarpments. The recency of the Turfan faults is proved by their relation to alluvial terraces. In Turfan, as in the other arid regions of Central Asia, the alternating moist and dry climates of glacial and interglacial epochs caused the streams to form five terraces. The oldest is large and much dissected, the youngest very small and fresh. All five of the terraces are found in the valleys which cut across the Fire mountains, but only the two lower ones are continuous on both sides of the fault line. The

other three were cut off by the fault, and end in mid-air where they reach the escarpment. On the downthrown side south of the fault they have been completely buried in more recent deposits. Evidently the little red range of the Fire mountains did not come into existence until the three major glacial epochs had passed away. By that time man certainly existed in Europe and probably in Asia.

The occurrence of the Fire mountain fault was most fortunate for man. If the inner edge of the zone of Piedmont gravel merged everywhere into the finer deposits of the central plain, most of the water from the mountains would be irrecoverably lost. Part, perhaps, would reappear in the form of a zone of vegetation, as it does in the Lob basin, but, nevertheless, Turfan would be almost uninhabitable. While the red range was being uplifted, floods from the Bogdo range cut gashes across it—narrow red canyons with wonderful scenery. A glance at the section on p. 254 shows that the heads of the canyons penetrate into the very heart of the gravel deposits which deeply fill the hollow between the Bogdo range and the Fire mountains. Thus most of the water, which seems to have been lost at the base of the higher range, is brought to light again. It wells out in springs at the upper ends of the canyons, where it supports a few villages upon the narrow terraces; then, with ever-increasing volume, it dashes down the steep red gorges and emerges upon the central plain, where it supports the largest among the flourishing oases of Turfan. Farther south and on either side of the main streams from the canyons, no surface water is available for irrigation. Hence the people have adopted the Persian device of the "kariz." This is an artificial scheme for doing what the red canyons do—that is, for tapping the water stored deep underground. Along the line of greatest slope of the central plain a tunnel is dug. It slopes at a less angle than the surface of the ground. Thus, beginning as an open ditch, it soon assumes the form of an underground tunnel, reached by wells from the plain above, and lying farther and farther below the surface as it is followed mountainward. Near its head it reaches layers of gravel or earth which are saturated with water. This flows down the gently sloping "kariz" until it reaches the mouth of the tunnel, and then comes to the light to support a village. Unfortunately, "kariz" water is more or less saline, and soon ruins the fields, unless they are very heavily manured. The lines of wells by which the "kariz" are entered and cleaned form one of the most unique features of Turfan. Everywhere one sees them by the score, each consisting of a mile or two of crater-shaped piles of gravel surrounding the closed mouths of the wells, which lie a few hundred feet apart. An imaginative Chinese told Sir Frank Younghusband that the hundreds of wells were the work of an invading army of his fellow-Celestials, who found that the heat of Turfan made water scarce. Every spring each "kariz" is cleaned. Professional "kariz"-men go

down the wells and clean out the year's accumulation of mud, together with a vast number of water-snakes, so I was told.

Looking at Turfan as a whole, the scenery of the basin is uninteresting. The lake is a mere mucky salt swamp; the plain, except where there are villages, is a monotonous expanse of reedy stubble and clay, with a little camel-thorn; the gravel slopes are dreary wastes of barrenness; the Sand mountains, though striking, are peculiarly sombre, by reason of the dark grey and deep purple shades of the long slopes. They lack the delicate details so beautiful in sand deposits of lighter weight and colour. The Desert mountains on the south are so flat-topped and subdued in general outline that one gladly turns from them;

OLD BUDDHIST MONASTERY EXCAVATED ON THE SOFT ALLUVIAL TERRACES OF THE UPPER END OF THE MURTUKH CAÑON NORTH OF KARA KHOJA, IN THE FIRE MOUNTAINS.

even the high Bogdo range on the north arouses enthusiasm only when one approaches it much more closely than the ordinary traveller or inhabitant of Turfan is likely to do. One feature alone, the little red range along the fault-line, redeems Turfan from being utterly commonplace and almost uninhabitable.

I first traversed the Fire mountains north of Lukchun, at the western end of the great sand area. As our caravan approached the mountains, the way led beside a swift brook, bordered by rows of willow, eleagnus, and poplar trees, and by orchards full of fruit-trees. A mile from the centre of Lukchun the guide—by order of the wang,

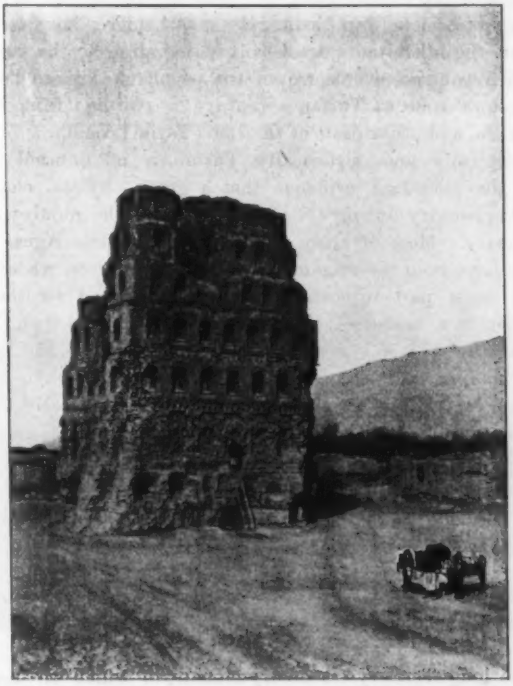
or native prince, a friendly boy of seventeen—led us to a large mud structure, that we might see a wonderful innovation. It proved to be a little cotton-gin, made within a dozen miles of my home in Massachusetts. It had been exported to Russia, taken to Siberia, and then carried 1000 miles on camels to Turfan. The fact that my people could make such a marvellous machine raised me greatly in the esteem of the natives, and seemed to make them think that the Russians had wronged them by saying that it had come from Russia.

On leaving the cotton-mill we soon came to the base of the steep red escarpment. The form is enough to prove its youth. It rises precipitately from a smooth base-line, which stretches away in an almost straight line far to the east and west. There are no projecting spurs, no retreating valleys. The canyons do not widen at their mouths, but end abruptly at the escarpment. The transition from the canyons to the plain is so sudden that later, after having come down a gorge to the escarpment, I felt as one does when he turns an angle in a narrow path in a dense forest, and unexpectedly finds himself looking out over the unbounded sea. On entering the canyon above Lukchun we found ourselves beside a rushing brook, plunging over naked red rock between high cliffs of gravel forming terraces, or of sandstone forming the main mass of the mountains. The wildness of the scenery set my Ladakhi servants from Northern India to talking merrily of their far-away gorges in the lofty Himalayas. At the end of 4 or 5 miles we emerged from the canyon at the village of Lemjin, lying on the terraces a little downstream from the springs in the Piedmont gravel. As we rode westward along the northern base of the Fire mountains, an utterly different type of scenery prevailed—a vast expanse of naked gravel, stretching northward for mile after mile to the base of the Bogdo range, and rising gently southward toward the top of the low featureless back slope of the red range. Then we turned south again into the narrow canyon of Tuyok, and at once were in another world.

When we came upon the huge ancient monastery or Buddhist lamasery of Tuyok, built largely in caves dug in the terraces, we felt as if we had suddenly been transported to Ladakh and the Himalayas. The village of Tuyok, itself a mere strip on the narrow terraces at the mouth of the canyon, might well have been in the Indus valley. Turfan is crowded with the ruins of Buddhist temples and lamaseries. Each of the ancient holy places has retained its character in spite of the change from Buddhism to Mohammedanism, and the shrines of the past are the shrines of to-day. The chief of them is here at Tuyok. The head sheikh entertained me in his own house. With the freedom from fanaticism characteristic of the Chantos, he took me into the inner shrine, where ordinary pilgrims are not permitted to enter. I fear it was a case of the power of the purse. He supposed that boundless wealth must belong to a man who travelled with a caravan costing

twelve or fifteen shillings a day—as much as the wages of a labouring man for a month. When the sheikh first heard of my approach, he sent a hasty messenger to recall his mother, who had started that morning for Lukchun to attend the wedding of the boy Wang. I remonstrated on hearing of this, but the sheikh answered—

"If the Wang should see her at the wedding, and know that she had



SACRED BUDDHIST TOWER AT SIRKIP, AT THE FOOT OF THE FIRE MOUNTAINS NEAR LUKCHUN. EACH NICHE CONTAINED A LIFE-SIZE FIGURE OF BUDDHA IN HIGH RELIEF. FANATICAL MOSLEMS HAVE DESTROYED AT LEAST THE HEADS OF ALL THE FIGURES.

left great guests at home uncared for, he would be very angry. He sent a special message that we were to show you every honour."

Etiquette obliged the sheikh's wife to mortify her curiosity, and hide her face and run away whenever she saw me; but his mother, simply because she was his mother, could not only speak to me, but could bring meals to my room, though her son must set them before me.

Tuyok is a peculiar town. All of its two hundred and fifty families live by grape culture. They say that they raise absolutely nothing

else, except a little fruit and a few vegetables for their own consumption. Their grapes, a small, seedless, green variety, are taken to Peking for the emperor's table. The raisins made from them are the best that I have ever tasted.

In connection with Tuyok and its special industry, it would be of great interest to attempt a study of the influence of physical environment in moulding the habits and character of the people of Turfan, and of the results of the commingling of Chantos, Chinese, and Mongols in this somewhat cosmopolitan basin. It must suffice, however, to say that most of the inhabitants are Chantos belonging to the same somewhat mixed Aryan race as the rest of the people of Chinese Turkestan. Their ancestors came to Turfan a century or two ago from Kashgar, Khotan, Ak Su, and other parts of the Lob (Tarim) basin.

Archæologically and historically Turfan is of unusual interest, because of the abundant evidence that a great physical change has come over the country during the Christian era. The number of ruins is extraordinary. Most of them date from the Middle Ages. A few of the ruins have been investigated by Russian travellers, whose reports are for the most part inaccessible; but it remained for the recent German expedition under Le Coq to study the archæology of Turfan for the first time with any great degree of thoroughness and scientific method. The reports of this expedition may be expected to throw a flood of light on the history of Central Asia, and especially upon the climatic changes to which the country has been subject. Turfan must be peculiarly sensitive to changes of climate because of its complete isolation from the rest of the world by high mountains, its extreme mid-continental position, and the almost rainless character of the basin floor as contrasted with the more ample precipitation of the surrounding mountains. Hence, if changes of climate have occurred in Asia during historic times, and if they have exerted an appreciable influence upon human history, the relation between climate and history ought to be peculiarly manifest in Turfan.

After the long Tertiary era of dry climate, of which we have seen evidence in the red strata of the Fire mountains, Turfan, in common with the rest of the world, experienced the climatic vicissitudes of the Glacial period. There were no glaciers in the region, except in the higher mountain valleys, but the moister or cooler state of the atmosphere caused the rivers and lakes to increase greatly in size. Hence, the term "fluvial" may properly be substituted for "glacial" in order to avoid the implication of glaciation when speaking of non-glaciated regions like Turfan. In Europe and America it is now generally agreed that the Glacial period consisted of several glacial epochs of ice-advance separated by interglacial epochs of warmer or drier climate, during which the ice retreated. In Turfan river-terraces and old shore-lines show that at the same time there was a similar series of cool or moist

fluvial epochs of river and lake expansion alternating with dry interfluvial epochs of river and lake contraction. Each succeeding epoch was less severe than its predecessor, just as successive glacial epochs in Europe were less and less severe.

At Turfan, however, there is a series of alternating lacustrine and non-lacustrine deposits, which indicate that previous to the series of *decreasingly* severe fluvial epochs mentioned in the last paragraph, there was a similar series of *increasingly* severe epochs. The deposits consist in part of pale greenish strata of solid clay, which was evidently deposited in the deep water of a large lake, the expansion of the present playa of Böjanti. At top and bottom these typical lacustrine strata pass into

VIEW LOOKING WESTWARD IN THE INNER FORT OF THE RUINS OF CHOUG ASSA (LARGE ASSA). THE HOUSES, LIKE THOSE OF EASTERN PERSIA, ARE MADE ENTIRELY OF ADOBE BRICKS WITHOUT THE USE OF WOOD EVEN IN THE DOMED ROOFS.

others, which were clearly laid down subaërially or in water so shallow that plants throve vigorously. Part of the non-lacustrine strata are composed of sand; others consist of clay full either of the fossil roots of reeds, or of black carbonaceous matter derived from plants of unknown species; still others take the form of bog iron ore, and some of genuine coal. Here and there in the non-lacustrine beds petrified trees are found. The number of alternations between lacustrine and non-lacustrine strata amounts to at least five, and probably more. All of the strata were probably deposited previous to the beginning of the *decreasingly* severe series of climatic oscillations recorded in the terraces

and beaches, and corresponding to the oscillations of the Glacial period in colder, moister lands. Two hundred miles south of Turfan on the borders of the enclosed lake of Lob Nor, and 1700 miles to the south-east around the similar shallow lake of Seistan, in eastern Persia, alternating lacustrine and non-lacustrine strata are found of essentially the same nature as those just described. The chief difference is that at Lob and Seistan there is no coal. The layers full of reeds are succeeded by distinctly subaërial strata of a pinkish colour, full of little stream-channels and other marks of running water, and sometimes showing rain-prints and mud-cracks, which could only be formed when the surface was exposed to the air. From the evidence of these three places it seems safe to conclude that, in central Asia at least, the Glacial or Fluvial period consisted of a long series of climatic changes involving ten, and probably more, complete cycles, during each of which the climatic passed from warm or dry to cold or wet and back again. At first the extremes of a given cycle were mild, but gradually they increased in severity until a maximum was reached, since which time they have decreased.

In many parts of Asia there is evidence—some of which has already been set forth in the *Journal*—that the last faint climatic pulsations of the Fluvial period are still in progress. Apparently two thousand years ago the country was decidedly cooler and moister than it now is. The early centuries of the Christian era, the Dark Ages, appear, however, to have been characterized by great aridity culminating approximately in the seventh or eighth century. Since that time there seems to have been a complete, though mild climatic cycle; that is, during the Middle Ages there was a partial return to the moister conditions of earlier times, while now the country has again become almost as arid as it was during the Dark Ages. There are many reasons for believing that this conclusion applies to Turfan. Unfortunately, we know but little as yet of the conditions prevailing in Turfan previous to about 800 A.D., but since that time there seems to have been a great climatic change. Grum-Grshimailo, a Russian explorer, visited Turfan in 1889. He says that though the swamp or playa was then, as now, very small and almost dry, Chinese records and an old Turfan song seems to indicate that formerly there was at least a large reed-swamp, if not a lake. The ruins of the town of Chong Assa and of the lamasery of Kichik Assa, at the east end of the swamp near a river-bed which is now dry, point, he thinks, to desiccation. "It would be of uncommon interest," he says, "if one could somehow know when this river existed. The well-preserved river-bed, the finely marked terraces, the ruins of the monastery of Assa on the bank, and a great number of isolated walls which are now half buried in sand—all these indicate that the river decreased in size comparatively recently."

My own observations agree with this on the whole, although I should judge that the ancient water-supply of Assa came from the

north rather than from the east. The largest of all the ruins, Grum-Grshimailo proceeds, are those of Kara-Khoja, a town which was founded between 874 and 913 A.D. After existing through mediæval times, it was finally abandoned at some time after 1644 A.D. The existence of this town coincides with the period of comparative recovery and slightly greater water-supply, which we have inferred during the Middle Ages. In the days of Kara-Khoja, Turfan was renowned for its library, its art, and its craft, as well as its might in war. To-day nothing of this remains. Formerly the region was so thickly populated that the chief of Gaochau, an unidentified town, could put ten thousand men in the field. "If," to quote the Russian explorer once more, "the land was so fruit-

THE OLD BUDDHIST MONASTERY OF KUHIK ASSA (LITTLE ASSA), SHOWING THE TURFAN PLAIN DOTTED WITH CAMEL-THORN. SAND HAS HALF BURIED SOME OF THE BUILDING.

ful, and the population so dense, the question naturally arises, whence came the necessary water for the irrigation of the fields, and for the support of the inhabitants." Grum-Grshimailo hints that the "kariz" may formerly have been more abundant than now, but his main conclusion is that a change of climate has taken place. He does not, however, attempt to decide whether the change was of local or of widespread occurrence.

The correctness of Grum-Grshimailo's conclusion as to the density of the ancient population is fully borne out by the vast number of ruins. They dot the plain, not only in districts which are now inhabited, but in more remote regions where no surface water is now available, and where

the underground supply is saline. Ten such places (Cholak, Assa Mazar, Pokluk, Böjanti, Olpang, Tura Kariz, Kakshal, Chong Assa, Kichik Assa, and Kosh-Dung) appear on the map on p. 257, and I heard of others. They form a well-defined zone which was once habitable, but is now too dry and saline for human occupation. In some cases the only relics of man's former presence are adobe "turas," as Buddhist stupas, or shrines, are called in this region, and a few bits of pottery. Elsewhere, as at Cholak, Chong Assa, and Kichik Assa, there are ruins of forts, houses, and lamaseries. The stupas appear to indicate the sites of villages, for they are on the prolongations of watercourses in places where agriculture would be possible if the streams were larger. Moreover, in Lulan and elsewhere, such stupas are the characteristic mark of villages. The forts mark the sites of larger villages or towns. At Chong Assa the pottery-strewn space included within the low outer wall is about three-quarters of a mile in diameter, indicating a considerable population. In addition to the main villages and towns there were probably smaller settlements of some sort. I found relics of these in the shape of forty or more stone graves on the edge of the southern zone of Piedmont gravel between Pokluk and Böjanti. Perhaps they belonged to shepherds, though now none come to the region, so far as my guide knew, because the water is saline.

Outside the zone of ruins located in places where no water-supply is now available, there is, as the map shows, a zone where practically the whole of the present water-supply comes from the "kariz," although formerly a population as dense or denser than that of to-day appears to have subsisted without its aid. During my stay in Turfan I visited all the chief towns, and made careful inquiries as to the total population, the proportion of the total supported by "kariz," the origin of the "kariz," and the location and age of abandoned "kariz." So far as I could learn, the "kariz" was introduced into Turfan from Persia, or Transcaspia at a comparatively recent date. The "kariz" is unknown in the Lob basin except at Imamla, where a Turfanik introduced it a few years ago. It has also been recently introduced at Hami, east of Turfan, but otherwise it appears to be unknown in Chinese Turkestan.

My most intelligent informants were the Beg of Lukchun and a learned mullah of the same place. They both said that the "kariz" was introduced about 1780 A.D., in the days of the Wangs Skender (Alexander) and Yunus (Jonah) of Lukchun, and Suliman (Solomon) who built the great brick tower at Turfan. Previously the people relied on surface water and wells. When I asked if there were no traces of abandoned "kariz" of an earlier time, they said, "No, none except those whose history is known. Among the ruins there are many old wells, half filled with rubbish, but no one has ever found any trace of a 'kariz.' There are some old ones which are now dry, but they were all dug since 1780 or thereabouts. At Assa about fifteen [two of which I saw] were dug sixty years ago

[about 1845], but the water proved so saline that the diggers gave them up without even building houses."

All the people with whom I talked said substantially the same thing, provided they had any idea at all about the matter. On the whole, it seems safe to conclude that the "kariz" is, comparatively speaking, an innovation in Turfan, and that the greater density of population in ancient times was not made possible by its more general use. On the contrary, under its stimulus there has been a marked increase in population during the last century, as I was told again and again. As nearly as I could ascertain, the population of the entire Turfan basin consists of 9500 families, or 50,000 souls. Of these, 5400 families are supported by

SCENE IN THE RUINS OF KARA KHOJA. IN THE NEAR BACKGROUND RISES THE RED ESCARPMENT OF THE FIRE MOUNTAINS, BEHIND WHICH CAN BE SEEN THE SNOW-CAPPED BOGDO RANGE.

surface water, and 4100 by "kariz" water. If it were not for the "kariz" the population of Turfan would be only 60 per cent. as great as at present, and would not number more than 30,000. Only the towns of an outer zone close to the Fire mountains, and at the east and west ends of the basin, would be habitable. There would be nothing to represent the ancient towns, which, though they had merely surface water to rely upon, once dotted not only the zone of the "kariz" villages, but also the still drier, more saline zone farther toward the playa.

In confirmation of the evidence of desiccation furnished by the ruins, the condition of vegetation deserves to be noted. The plain is covered

with beds of dead reeds. Evidently the region was once densely clothed with reeds which have died long since, and have now been broken off level with the ground by the wind. The dead reeds are so abundant that people from the towns dig out the stalks for fuel. Every morning one sees donkeys with bulky loads of ancient reed-stems brought into the bazar from distances of from 5 to 15 miles. The reeds are sold for fivepence a load. The price made a great impression upon my men, for at Tikkenlik, near Lob Nor, a month earlier, we had paid a halfpenny a load for the very best poplar or tamarisk wood. The death of the vegetation may be due in part to the increased use of the streams for irrigation, and to the lowering of the water-level by the digging of "kariz." It is so universal, however, that it is doubtful whether it can all be due to man's agency. Dead reeds occur not only near the villages, but far from them; not only between the "kariz," but below their mouths where the level of ground water has been raised instead of lowered so far as man's action is concerned. Altogether it seems reasonable to suppose that the death of the reeds and the decrease of the population are both due to desiccation.

The history of Turfan, so far as it is known, agrees with what one would expect if the preceding conclusions as to changes of climate are correct. In the earliest Chinese records, dating back nearly two thousand years to the first historical fluvial epoch, Turfan is spoken of as highly prosperous. During the succeeding interfluvial, or dry epoch, embracing roughly the third to the eighth centuries, it almost disappears from history, and seems to have suffered great misfortunes and depopulation. In Asia and Europe alike the Dark Ages appear to have been darkened by the same cause, namely, the distress and migrations caused by adverse climatic conditions in arid regions. The Mediæval fluvial epoch, as we have seen in the case of Kara Khoja, was a time of great prosperity. People flocked into Turfan from every direction, as is evident from the manuscripts in *ten* different languages which Le Coq has found. Aryans appear to have come north-eastward from India; Tibetans northward from their plateau, which was growing cooler and moister and less habitable; Chinese from the east; Mongols and Turkish races from the north; and Syrians—probably Nestorian Christians—from the west.

The prosperity of Turfan came to an end at the close of the seventeenth or early in the eighteenth century. The basin was left almost without inhabitants. At first sight such complete depopulation seemed anomalous. That is, it is anomalous in the sense that so far as climate is concerned there seems to be no direct reason why Turfan should not then have been at least as populous as it was before the introduction of the "kariz," and possibly more so. On closer examination, however, it seems probable that the extreme depopulation of two hundred years ago was due indirectly to the influence of climate. The direct cause

of the disappearance of the people from the villages of Turfan was the raids of plundering Mongol nomads from the surrounding mountains. To-day there are no Mongols in the mountains; the country is too dry. The nearest are at Kara-Sher, 150 miles away. In mediæval times, however, when there was more moisture and vegetation, the mountains are said to have afforded homes to bands of Mongol nomads. So long as they prospered, they lived, we suppose, on terms of comparative peace with their neighbours in the plain. When the change from the mediæval climate to that of to-day began to take place, the nomads must have been the first to feel the pinch. Life, we may suppose, became hard as their cattle and flocks began to dwindle. For this reason, presumably, the bold mountaineers began to plunder their weaker neighbours in the villages. The plain gradually lost a large part of its settled inhabitants, and there was no chance for it to recover while the Mongols remained. The Mongols, more than almost any other race, despise agriculture. Therefore, though they occupied the plain, they did not cultivate it. They still presumably migrated from the plain to the mountains in summer, and ceased to do so only when the mountains became so dry as to be useless for flocks. Then they migrated farther, perhaps dispossessing some other tribe, and Turfan was left open once more to settlement by Chanto immigrants from the Lob basin. The depopulation was merely an episode accompanying the reduction of the mountains to a state where they were too dry to be inhabited by nomads. As an historic incident, it is scarcely worth recording. It may, however, typify events which have taken place on a scale involving continents. If so, it illustrates a great factor which has been neglected in the study of history.

During the last century Turfan has again enjoyed a period of comparative prosperity by reason of the "kariz." The "kariz" has nothing to do with changes of climate directly, but it illustrates how the pressure of difficulties stimulates human inventiveness. The increase in population and in prosperity since its introduction affords an admirable example of man's ability, not only to neutralize, but even to overbalance adverse changes in physical environment.

ON THE INFLUENCE OF ICE-MELTING UPON OCEANIC CIRCULATION.*

By Dr. OTTO PETTERSSON.

(Second Paper.†)

By evaporation of 1 kilogram of sea-water under due precautions we obtain a residue consisting of the solid saline matter dissolved in the water. If we, for example, suppose the weight of this residue to be 35·04 grams, hydrographers in our countries

* Read at the Royal Geographical Society, June 10, 1907.

† See *Geographical Journal*, vol. 24, p. 285.

immediately recognize such water, on account of its relatively high salinity (35·04 per mille), to be Atlantic water, which must have been carried to our latitudes by the great warm-water current of the Atlantic ocean. The determination of salinity in sea-waters thus becomes a matter of importance to hydrographers, because it enables us in a certain degree to trace the origin of waters. The first international conference in Stockholm, 1899, decreed that salinity shall be determined with an accuracy of at least $\frac{5}{100,000}$ or 0·05 per mille of the weight of the water. The direct determination of the salinity of a water is, however, a delicate and difficult operation. Hydrographers therefore usually prefer to calculate the salinity from the amount of halogens per mille contained in the water, or from its density at zero (σ_0). The former quantity, per mille Cl, can be ascertained with a very high degree of accuracy (up to 0·01 per mille) by titrimetric methods involving the use of "standard water," and the density can be measured by physical methods with a corresponding exactitude. The results agree usually perfectly, as will be seen from the following example: S_{Cl} denotes the salinity calculated from the chlorine titration (by the aid of Knudsen's tables *), S_{σ_0} the salinity calculated from the density.

In three water samples † taken on May 31, 1900, in Barents sea, lat. 71° 48′ N., long. 49° 38′ E., by Wollebaek, the Norwegian chemists Leivestad and Schetelig found—

Depth of the sample.	Halogens, Cl per cent.	Salinity, S'_{Cl}	Density, σ_0.	Salinity, $S'\sigma_0$.
50 metres	19·30 per cent.	34·87 per cent.	1·02803	34·88 per cent.
70 „	19·305 „	34·88 „	1·02803	34·88 „
100 „	19·30 „	34·87 „	1·02803	34·88 „

There seems thus to exist a strict correspondency between the amount of halogens, the density, and the salinity of sea-water.

The relation of salinity to halogens in the waters in question is—

$$\frac{\text{salinity}}{\text{halogens}} = \frac{34{\cdot}873}{19{\cdot}30} = 1{\cdot}807$$

and the ratio—

$$\frac{\text{salinity}}{\text{density}} = \frac{34{\cdot}88}{1{\cdot}02803} = 3{\cdot}391$$

Variations in the Chemical Composition of Sea-water from the Tributaries of the North Atlantic Ocean.

Some ten or fifteen years ago the question was much debated, whether these ratios were constant and representative for all kinds of sea-waters. In that case the numbers 1·807 ("chlorine coefficient") and 3·391 ("density coefficient") would assume the character of constants of nature which ought to be determined with the greatest possible accuracy. Dittmar found the ratio between salt and halogens in oceanic waters to be = 1·805. Tornœ, in his analyses of waters from the Norwegian sea, used the coefficient 1·809; and F. L. Ekman finally, as a mean number from his experiment with Baltic waters, introduced the factor 1·81.

When I, in 1881, assisted by G. Forsberg, analyzed the water-samples of the *Vega* expedition, we found still higher values for the chlorine factor, viz. up to

* 'Hydrographische Tabellen,' herausgegeben v. M. Knudsen. Köbenhavn: 1901.

† F. Nansen, 'Northern Waters,' p. 40. Christiania: 1906.

1·83, and we constated *that the ratio: salt to halogens was greater in coastal waters, as, for example, in those from the Siberian sea or the Baltic, than in oceanic water.* The reason was obvious. If we dilute a sea-water sample with pure water, the relation of its saline constituents to each other remains constant. In the Siberian sea, the Baltic a.O., the Atlantic water becomes diluted from admixture with the water of rivers, which contains a small quantity of salt of other composition than sea salt. The chief difference is that river-water contains less chlorides and more sulphates, silicates, etc., in proportion than sea-water. This accounts for the fact that the proportion of salt to halogen in a sea-water increases the more it is diluted with fresh-water from rivers, while the proportion of salt to density is not altered correspondingly.

The International Hydrographic Conference of Stockholm in 1899, therefore, found it indispensable to arrange for a revision of the physical and chemical constants of sea-water before the commencement of the international hydrographic research. The result of this revision is contained in the 'Hydrographische Tabellen' of M. Knudsen, which is founded upon analyses of about thirty sea-waters from different localities in the Atlantic and Indian ocean, the North sea, the Baltic, Mediterranean a. O. Thereby the variations caused by river-water a. O. influences in the coastal regions of the ocean are taken into account, so that we are able to calculate the halogen from the density, and *vice versâ*, and the salinity either from the halogen or the density, with the result shown above, viz. the S_{Cl} and S_{σ_0} are identical up to 0·01 per mille in all ordinary cases. It must, however, be observed that this high degree of accuracy can be expected to hold only for such waters as those which formed the basis of Knudsen's analyses, viz. waters from the surface of the tropical and temperate parts of the Atlantic and Indian ocean and their tributaries. Arctic waters and water from the great depths of the oceans formed no part of Knudsen's research, because the influence of river-water must be confined to the uppermost layers.

The investigation of the hydrographical constants of sea-water has now been extended to arctic waters and deep waters by Nansen, Helland Hansen, Schetelig, and Leivestad. In a treatise from 1906, 'Northern waters,' Nansen communicates the following interesting facts,* which prove that some other cause than the admixture with river-water must be working in the ocean, which can exercise influence upon the quantitive proportions of the constituents of its water. This influence manifests itself by exceptions from the rules laid down in Knudsen's tables, *imprimis* by the fact that S_{Cl} becomes $\gtrless S_{\sigma_0}$ for such waters.

I. In the upper water-layers of the Barents sea, from 0 metre to 40 metres depth, there was found in May, 1900, an excess of halogen, S_{Cl} being about 0·026 per mille greater than S_{σ_0}.

II. In the upper water layers of the sea east of Greenland, the amount of halogen in July, 1901, was found slightly too small, S_{Cl} being about 0·008 per mille lower than S_{σ_0}.

III. The deep water of the eastern part of the Barents sea is deficient in halogen, S_{Cl} being up to 0·015 per mille lower than S_{σ_0}.

IV. The deep water of the Norwegian sea is also deficient in halogen, S_{Cl} being between 0·01 and 0·03 per mille lower than S_{σ_0}.

The cause of these anomalies in the normal composition of sea-water is the freezing of sea-water in the Arctic regions of the ocean, and the melting of sea-ice, which is transported to lower latitudes by the polar currents.

* F. Nansen, 'Northern Waters,' pp. 10, 12, 40, 51, etc.

Being commissioned by A. E. Nordenskiöld, in 1880, to work out the hydrographical results of the *Vega* expedition, I found among the great number of water-samples to be analyzed some flasks containing a very concentrated brine, which had been collected upon the ice-fields of the Siberian sea, where it formed shallow ponds or lagoons upon the ice. Around these lagoons was found a mass of minute salt-crystals, so thickly crowded that they resembled a vegetation of lichens around the borders of the lagoon. The Russian denomination of such crystals is "rossol." This was evidently a product of the freezing process of sea-water under the intense winter cold of these regions. On analysis, both brines and crystals were found to possess a chemical composition which quantitatively was extremely different from that of the sea-water from which they had formed. The most prominent difference was the excess of halogen, in proportion to the salinity on the whole, and especially to the amount of sulphuric acid, which was found to exist both in the brines and in the "rossol" salt. I was naturally led to the assumption that those constituents of the sea-salt which were found in reduced quantity in the residue after the freezing process, viz. in the crystals and the brines, must have entered into the composition of the sea-ice. This was also found to be the case in a great number of analyses of sea-ice of different origin, which Mr. Forsberg executed at my * request. From these facts I arrived at the following conclusions :—

(1) Ocean-water is divided by freezing, not into pure ice and a more or less concentrated solution of ordinary sea-salt, as was formerly believed, but into two saliniferous parts, one liquid and one solid, which are of different chemical composition.

(2) The formation of sea-ice is chemically a selective process. Some of the elements of the salt water are more fit than others to enter into the solid state by freezing; those which are rejected by the ice will preponderate in the brine, and *vice versâ*. Taking the relation $Cl : SO_3$ as standard of comparison, we may characterize the most striking feature in the freezing process thus—that the ice is richer in sulphates, the brine in chlorides.

(3) The extraordinary variation both in salinity and chemical composition of every individual specimen of sea-ice and sea-brine depends upon a secondary process or metamorphosis of the ice. Its ultimate tendency is similar to that of the original act of freezing. The ice seems to give up its chlorides more and more, but to retain its sulphates. The cause of this metamorphosis has justly been ascribed to the combined influence of time and variations of temperature.

At that time the general opinion was that pure ice was formed at the freezing of sea-water. The small impurities always present in sea-ice were accounted for by adherent sea-water. The fact that the freezing of sea-water involves a separation of its chemical constituents, of which one part enters into the composition of the solid, another into that of the liquid water, made this theory untenable. All our analyses of sea-ice showed an excess of sulphates relatively to chlorides. The salinity of the ice was of course small, and was found to diminish with the age of the ice. But at the same time the disproportion between its content of sulphates and of chlorides became more and more accentuated. Immediately after its formation, sea-ice contains a noticeable quantity of salt—chlorides as well as sulphates, carbonates, etc., with only a slight preponderance of chlorides. Such ice is very different from fresh-water ice in its physical properties. It melts under zero, and begins to show signs of melting by contraction of volume at temperatures far below zero. Thus I found that a sample of ice which contains 0·15 per mille of chlorine,

* O. Pettersson, 'On the Properties of Water and Ice,' pp. 305. (Vega expeditionens vetenskapliga iakttagelser, 1883.)

begins to contract already at −40° C.; that an amount of chlorine of 2·73 per mille causes the ice to contract already at −14° C.; and that ice, formed by freezing at low temperatures of arctic sea-water which contained 6·49 per mille of chlorine, began to contract its volume already at −18° C. The following diagram shows the changes of volume which such ice, formed by freezing of 1 c.c. ice-water (at 0°) containing 6·49 per mille chlorine, undergoes from −19° C. to its melting-point, −0·7° C., compared with the corresponding volumes of pure ice formed by freezing of 1 c.c. distilled water, which ought to melt at zero. The diagram shows, however, that even such ice is not totally exempt from small traces of impurities which cause the ice to contract its volume at 0·1° or 0·2° C. below zero.

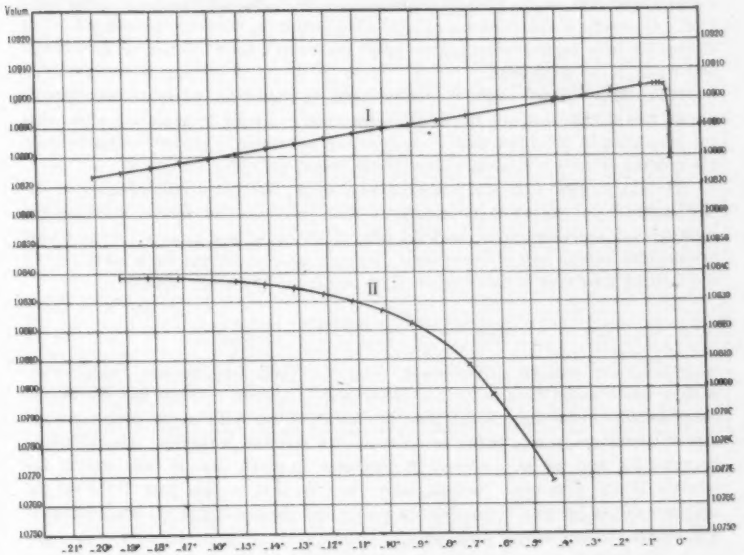


FIG. 1.

The curves I. and II. represent the extreme limits of volume which any ice formed in nature can assume between −20° C. and 0°. The ice formed in the wakes between the ice-floes of the polar sea or in Arctic fjords * under the influence of intense atmospheric cold will, when exposed to temperature changes, behave in a similar manner to that represented in curve II., while such ice as has outlived one or more summer seasons in arctic seas, and meanwhile been transported with the

* E. V. Drygalski ('Grönland-expedition der Gesellschaft für Erdkunde zu Berlin, 1891–1893,' p. 425) found the salinity of newly formed sea-ice to be 4 or 5 per mille. His researches bear out the important fact that the salt is not confined to the uppermost layer of the ice, as Weyprecht believed ('Die Metamorphosen des Polareises,' Wien, 1879). On the contrary, the salt was found to be almost equally distributed in every layer of the sea-ice from the surface to 68·4 cm. depth, where the salinity was 4 per mille. But after two months (from April to June) the salinity in all layers had decreased from 4 or 5 per mille to 1 or 2 per mille.

polar current southwards has undergone a metamorphosis which results in a decrease of the saline constituents on the whole, and leaves nearly pure ice (curve I.), only containing small traces of sulphates, carbonates, etc., which are first given up to the surrounding water when the ice melts.

In my treatise 'On the Properties of Water and Ice,' I tried to explain the chemical changes which accompany the freezing of sea-water * by the formation of kryohydrates or eutectic combinations of salt and water in the solid state. According to Guthrie, the sulphate of sodium forms a kryohydrate with a melting-point nearly equal to that of sea-ice, viz. $-7°$ C., while the melting-point of the kryohydrate of sodium chloride is $-22°$ C. I imagined that such kryohydrates were enclosed in the sea-ice, which thus contained a number of different kryohydrates, as a crystalline rock, *e. g.* a granite, contains feldspar, mica, and quartz. After van't Hoff's discovery of the existence of solid solutions, it is, however, necessary to view the matter from another side, and to regard sea-ice as a solid solution or alloy of salt and water in the solid state.

When this "alloy" melts in warmer parts of the ocean, its saline constituents are set free to mix with the surrounding sea-water. I tried to explain the fact that the proportion of sulphuric acid to halogens in sea-water is slightly variable from the melting of sea-ice in certain parts of the ocean.

Already in 1883 this idea was confirmed by A. Hamberg, hydrographer to the Nordenskiöld expedition to Greenland of that year, who by several series of the most careful analyses proved that the ratio of SO_3 to Cl was greatest in the waters of the polar current east of Greenland. In such samples as had been taken among the drifting ice-flakes of that current Hamberg found the mean relation—

$$100\frac{SO_3}{Cl} = 11{,}499$$

while the mean ratio for surface water from the North Atlantic and Irminger sea with a temperature from $+3°$ to $+11°$ C. was $-11{\cdot}486$. When the Norwegian chemists have found $S\sigma_0$ greater than S_{Cl} by 0·008 per mille in the surface waters east of Greenland, this is in full accordance with Hamberg's results. The difference between $S\sigma_0$ and S_{Cl} is, however, in this case so small that it falls within the possible limits of errors. Nansen justly observes, that in this part of the sea the influence of the freezing of sea-water in winter and the melting of sea-ice in summer will almost counterbalance each other.

In the Barents sea, and still more in the sea east of Franz Josef Land, we meet with different conditions. Here the influence of the freezing of sea water prevails in the upper water-layers (from 0 to 40 metres), as shown by the analyses of Captain Amundsen's samples taken on May 9, 1901, at 69° 32′ N. and 45° 37′ E., in which $S_{Cl} > S\sigma_0$ by 0·026 per mille; and of Makaroff's samples taken in August, 1901, at 78° to 80° N. lat. and 61° to 64° E. long.†

In the deep waters of the Barents sea conditions are reversed, S_{Cl} being less than $S\sigma_0$, whenever the temperature is much below zero, as, *e.g.*, in Makaroff's water-

* Mr. W. E. Renger has newly studied the chemical changes caused by artificial freezing of sea-water at low temperatures: "Ueber die Veränderungen in der Zusammensetzung des Meerwassersalzes beim Ausfrieren" ('Verhandelingen mit het Rijksinstitutet voor het onderzoek der Zee.' Helder, 1906). The composition of the salt which enters into the solid and the liquid part of sea-water at $-5°$, $-8°$, $-10°$, $-25°$, $-30°$ C. has been studied elaborately by Mr. Renger, who denotes $-8°$ C. as the temperature at which the freezing sea-water begins to give up its sulphates to the ice.

† 'Northern Waters,' pp. 10 and 51.

samples from 100 and 200 metres in 80° 26′ N. lat. and 64° 14′ E. long., and in Wollebaek's samples from 71° 48′ N. lat. and 49° 38′ E. long., where the temperature was −0·9° C. to −1·7° C. and $S\sigma_0 > Sc_1$ by 0·015 per mille.

The same holds also with regard to the deep water of the Norwegian sea. This puts the question from another point of view, and our chief interest will be centred round the problem: Can this deficiency in chloride and superfluity of other salts be effected by the ice melting?

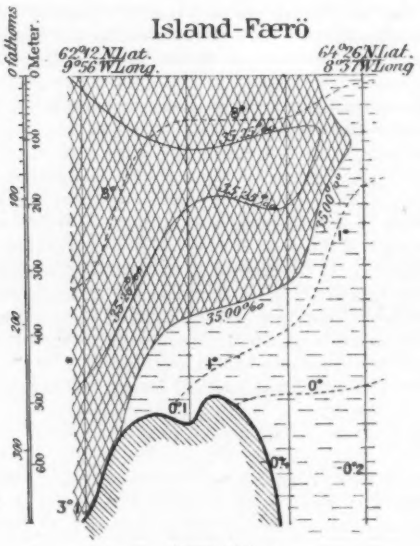
Is it possible that the Barents sea at 350 metres depth, and the bottom layers of the Norwegian sea at 3000 to 4000 metres, are influenced by the melting of the ice, which phenomenon of necessity is limited to the surface layer wherein the ice floats?

The following experiment, which can easily be made before the lantern, will give a direct answer to this question.

FIG. 2.

Thirty-five grams of chloride of sodium are dissolved in 1 kilogram of water. The solution is heated to its boiling-point. The small quantity of sulphuric acid which exists as impurity in the salt is precipitated with barium chloride in slight excess. After filtration we have a saline solution which has the same density, and on the whole the same physical properties, as ordinary sea-water, but differs from it chemically, in so far that it does not contain any sulphates. A parallelopipedic tank is filled with such water. A small piece of sea-ice, formed by the freezing of ordinary sea-water (which ice contains a small amount of sulphates), is introduced at one side of the tank. The current system shown in Fig. 7 on p. 295 of the former paper (*Geogr. Journ.*, vol. **24**, No. 3) immediately sets up. The undercurrent which runs towards the ice is quite transparent, while both above and below it the reaction between the barium salt in the water and the sulphates in the ice appears in the upper ("polar") current as well as in the ("arctic") bottom water, which flows along the bottom and banks up against the opposite wall. If the glass jar is provided with a partition (a piece of indiarubber) which reaches halfway up to the surface (Fig. 8, p. 296 *loc. cit.*), the experiment gives a striking illustration of the water-circulation of the Norwegian sea. The flow of the bottom current is made visible by the motion of the minute crystalline particles of the precipitate as it rises over the top of the partition and sinks down again to the

bottom on the other side of it, in the same manner as the cold bottom water of the Norwegian sea banks up against the Iceland Färoe ridge in the following section, and finds its way into the Atlantic ocean. This cross-section of the ridge has been repeated three times by the Danish expeditions. Fig. 14, on p. 305 of the former paper, gives the situation in August, 1903; the following figure is from August, 1904:—



August, 1904.

FIG. 3.

The ice in the experiment is melted by the heat of the surrounding water. But the water which has given up its heat to the ice has undergone a change. In the first place it has been cooled down to very near its freezing-point, thereby contracting in volume and becoming heavier and denser than the surrounding water, and thus sinks to the bottom. Secondly, it has absorbed water from the melted ice, and at the same time some of the substance held in solution by this water. This is made evident when analyzing bottom water which has been formed by contact with the sea-ice. In such water the percentage of chlorine is less than in common sea-water. When the Norwegian chemists found that the ice-cold bottom layer of the Norwegian sea held some 26 million parts higher salinity than was conformable with its percentage of chloride, so is this an evidence that this water was originally Atlantic or Gulf Stream water which has partaken in the process of ice-melting and become metamorphosed or transformed into Arctic bottom water.

Thus the ice melting in the Norwegian and North Polar sea produces a layer of cold water of about $-1{\cdot}3°$ temperature at the bottom of this huge basin, with a salinity of 34·93 per cent. Its temperature is about half a degree above the freezing-point of the water. It will be important in the future to watch the changes that may occur in the temperature of this water-layer. Should it show

signs of a rising temperature, then this indicates that the heat conditions in our parts are improving because more Gulf Stream water is brought hither. If the temperature decreases ever so slightly, so will this indicate that the great warm-water artery of the North Atlantic is ebbing.

Evidently the water masses carried by the Gulf Stream from the tropics to the polar sea cannot for ever go on being amassed there, but must somewhere be transformed into Arctic water. This change takes place when the water is brought into contact with the ice, and this contact gives to the water two typical features, viz. a low temperature with accompanying great density, and a small, but by careful analysis just discernible, deviation from the normal percentage of salts, consisting in an abnormally low percentage of chloride as compared to the total salinity.

The sea-ice formed in winter in the polar sea by freezing on the surface or the layer immediately below does not remain as a thin unbroken cover of the sea. It is continually broken, and the ice-floes are submerged under each other. In this manner the great ridges and screwings are formed which can measure up to 30 feet above the surface of the polar basin. Yet these "torosses," as the Russians call them, have their greatest bulk below the surface, and *it is in their undermost layer that the melting is most intense.*

The site of the ice-melting is always marked by the low temperature which notes the point of equilibrium between ice and salt water, and by soundings in the polar sea a temperature minimum is almost always found at a certain depth below the surface. This minimum marks the greatest depth to which the screwed ice or icebergs reach. In the polar basin this point is found at about 60 to 80 metres; in the Greenland ice-current, according to Hamberg, at about 50 or 100 metres. In the Antarctic, where the icebergs obtain a mean height of about 60–70 metres above the surface* and 300–500 metres below, the minimum will be found at about 300 metres.

It does not follow that every particle of Atlantic water need come into contact with the ice. If this was the case, the temperature of the water in the Norwegian sea must correspond to the point of equilibrium between ice and salt water of 34·93 per cent. or $-1°{\cdot}9$. As the lowest bottom temperature is $-1°{\cdot}4$, or half a degree above that point, this is an indication that the supply of Atlantic water is in excess, so that every particle of this water need not touch the surface of contact. All partake in the melting phenomenon by giving up their heat to the ice, but only part of them will reach the actual surface of contact and absorb some of the melted ice-water with its percentage of sulphate, etc. In the neighbourhood of the ice these particles mix with the other cooled particles which have not been in contact with the surface and sink bottomwards. We must not expect to find real unaltered Gulf Stream water in the immediate neighbourhood of the ice. A layer of more diluted water is always found round the ice in which the melting is conducted. The bigger this area of mixed water, the tardier the melting. In the polar sea we have instances both of quick and tardy melting. When the polar current pushes icebergs into the very Gulf Stream area, as is the case (in certain seasons) south of Cape Farewell, or outside Newfoundland in spring, extraordinary strong movements in the sea-water occur. Such regions I have named *centres of activity of the ocean.* When the polar current in certain seasons retreats, or where it passes over shallow banks, and also in the interior of the Greenland fjords and in the proper polar basin, the ice melts very slowly.

The Russian section of the International Investigation of the sea has discovered a bottom current along the coast bank of Novaya Zemlya, the salinity of which (35 per mille.) equals that of the Gulf Stream water in the Norwegian sea, and whose

* According to Fricker.

temperature is about 1°·7 or more below zero. This is the coldest and saltest water known to exist on the globe. Unsuccessful attempts have been made to measure the velocity and direction of its current, and many theories have been made regarding its origin. From the west, from the Norwegian sea, it cannot have come, for in the western parts of the Barents sea no bottom water of this salinity and temperature has ever been traced. It has been suggested that it might be a bottom current from the Kara sea entering through the Kara strait and following the west coast of Novaya Zemlya northward. The latest suggestion * is, that the

FIG. 4.

water does not belong to any deep current at all, but is formed at the place—that is, on the surface through the concentration of the surface water in freezing. This, however, is impossible; for if ice had formed in this water, its percentage of chlorine should have exceeded, instead of being less, than the normal. My belief is, that this cold deep current is a branch of the Gulf Stream in the polar basin, which, coming into contact with the ice north of Franz Josef Land, has been cooled down to nearly the lowest temperature possible for such water. Earth rotation has

* F. Nansen, 'Northern Waters,' pp. 43, 44.

then deflected its course to the right, round Franz Josef Land, and towards the west coast of Novaya Zemlya. Makaroff, forcing the ice between Franz Josef Land and Novaya Zemlya with the *Yermak*, found in his soundings cold salt bottom water of this type. The samples taken he sent to Nansen, and the analysis of those from the greatest depth gave the result here stated, viz. deficiency in chlorine as compared to salinity. The accompanying map (Fig. 4) shows schematically my idea of the courses of the last branches of the Gulf Stream in the polar sea. Full-drawn lines denote surface currents, dotted lines under-currents, broad lines Atlantic, fine lines Arctic water.

The current chart is an emendation of that in Fig. 20 on p. 313 of my former paper. In the present chart, the Atlantic water in the north-eastern part of the Barents sea is supposed to come as a *cold* bottom current from the north, not from the south. Without hesitation I can now protract towards the Barents sea the current line for the first ramification of the Gulf Stream in the polar basin. Makaroff, Knipowitch, and Wollebaek have all found this cold and salt water in different latitudes in this sea. The high salinity shows that it contains Gulf stream water, which has been transformed into Arctic bottom water characterized by its low temperature * and low percentage of chloride.

The Influence of Ice-melting upon the Water Circulation in the Atlantic and Indian Ocean.

The ice-melting experiment in Fig. 2 shows how a current (the polar current) is set up in the surface when the ice melts, and also how cold and salt Arctic bottom water is formed, which flows on until stopped by some hindrance, and then builds up into a wall of cold water against this hindrance. I will now show how the same phenomenon takes place also in other seas than the Norwegian. A hydrographic section from surface to bottom along the 75th longitude in the Indian sea would, according to G. Schott,† show the termal situation represented in the accompanying figure.

This figure resembles perfectly the situation in our ice-melting experiment. The wedge of warmer water of +2° C. in 300 metres depth, that appears to advance towards the 60th parallel S., is identical with the warm under-current which approached the undermost side of the ice in our experiment (Fig. 2) and occasioned

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* Knipowitsch ('Grundzüge der Hydrologie des Europäischen Eismeeres,' p. 194: Petersburg, 1906) points out that the high amount of nitrogen dissolved in this cold bottom water makes it probable that it has been saturated with air in winter time somewhere north of Nova Zemlja. According to Hamberg's tables, the water ought to have been saturated with air at −2°·85 C. Its actual temperature *in situ* was −1°·7 C. This sounds paradoxical, and warns us not to draw conclusions rashly regarding the temperature of absorption from the nitrogen in bottom waters. There may be other gases than atmospheric nitrogen in such waters, or the nitrogen may derive from other sources than the atmosphere, *e.g.* from the putrefaction of organisms in the bottom mud. A closer inspection of the gas analyses given in Knipowitsch's paper on p. 1206 reveals the fact that the oxygen percentage is very reduced (26·8 to 29·3 per cent. instead of 34 per cent.), and that the carbonic acid is exceptionally high (49·9 c.c.). Such marks in a water from the deepest layer of the sea are far more conclusive than the crude nitrogen determination, which, from the reason named above, may be fallacious. They bear out the probability that the coldest and saltest bottom water of the Barents sea has been excluded from contact with the atmosphere during a relatively long time.

† G. Schott, 'Wissenschaftliche Ergebnisse der Deutschen Tiefsee-expedition auf dem Dampfer Valdivia, 1898–1899,' Bd. I.

the melting. The wedge-shaped layers above on the surface belong to the polar current, and are formed by sea-water mixed with water from melted ice, as in the experiment. Lastly, there is a powerful descending current of salt water, which has given up its heat to the icebergs and now sinks to the bottom of the ocean, flowing towards the equator till stopped and pressed up into mountains of cold

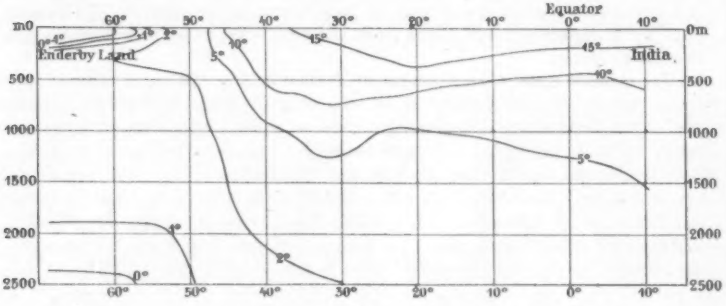

FIG. 5.

water by the southern coast banks of Asia as, in our experiment, the cold bottom current was pressed up against the partition or the opposite wall of the glass tank.

Looking now at the Atlantic ocean, and imagining a longitudinal section along the 30th meridian west of Greenwich, the temperature of the water will be distributed as in the figure below. Here we find the same typical formation—a wedge

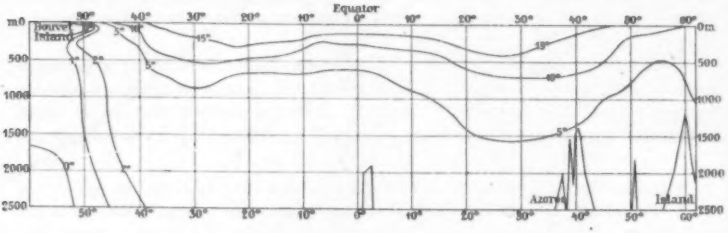

FIG. 6.

of warm water under the surface advancing southwards to melt the Antarctic ice. Above is the polar current, and below is the cold bottom water pressed up into a mountain of cold water under the equator. We might ask, Which is the counteracting agent that forces the bottom water to rise in such a way under the equator? The answer will be, the Atlantic differs from the Indian and Pacific oceans therein, that it borders on ice-filled polar seas both in north and south.

In the Atlantic the ice-melting is conducted both in the Antarctic and in the northern parts of the Arctic sea, from Greenland and Iceland to Newfoundland. The Atlantic thus possesses two sites of melting for the ice, and in its centre, below the equator, the cold bottom currents from both hemispheres meet. The circumstances of this meeting we may derive from the following experiment:—

We put two lumps of ice into our glass vessel, which contains such salt water

as described on p. 287, one at each end of the vessel. The current system that arises is pictured in the above figure. The cold bottom currents meet in the centre of the vessel, which answers to the equatorial area of the ocean, and there their water masses form into a mountain of cold bottom water. The similarity of the situation in the ocean and in the experiment is perfect to the smallest details. We have here

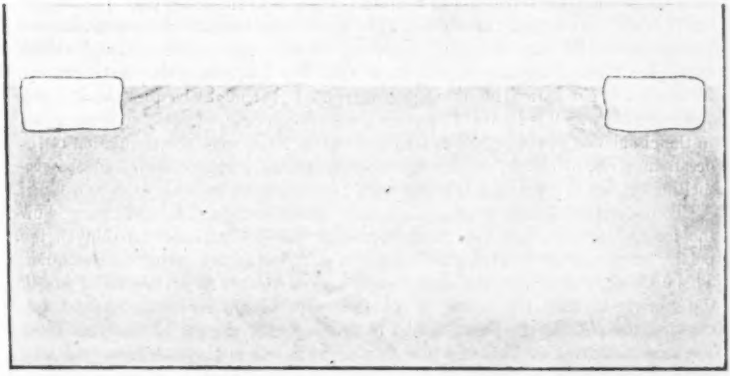

FIG. 7.

the explanation of the remarkable fact that in one of the Earth's warmest localities, the Guinea gulf, where the sea has a temperature of up to 28° C., the warm water-layer is thinner than anywhere else, for only some hundred metres below the surface we find water of 4° or 5° C. *This is probably an effect of the updrift occasioned by the ice-melting in the polar seas.*

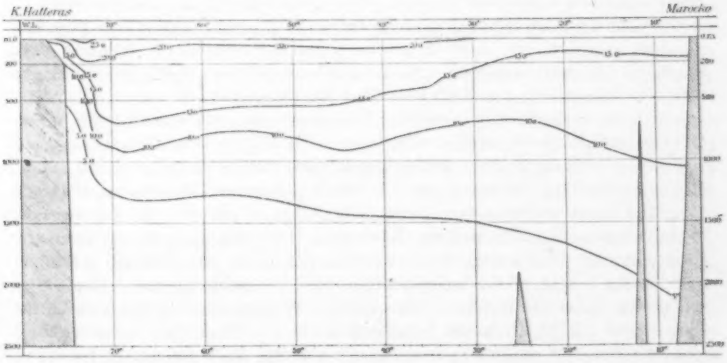

FIG. 8.

It is not only below the equator that this amassing of cold bottom water takes place. We have observed the mighty wall of cold water to the north of the Färoe-

Iceland ridge. Take a section across the North Atlantic from America to the coast of Morocco.

We see how the temperature lines, or "isotherms," rise towards the coasts of the two continents. Here, then, is another updrift of the cold bottom water of the ocean when pushed against the coast banks. Thus between the warm layers of the Gulf Stream and North America's coast there is a ridge of cold water, "the cold wall," and such is the case also on the other side of the ocean too.

It is easy to see that the water which gives up its heat to the ice must become cooler and heavier than its surroundings, and therefore sink to the bottom, breaking through all interlying layers, and that thus the ice-melting in the ocean can influence the circulation in its deepest layers. But it might be questioned if this phenomenon, which is limited to certain areas of the ocean, can play so great a part in the circulation of the oceans as I have suggested. To work the circulation of the ocean involves, of course, an immense expenditure of energy. How can the ice-melting deliver so great an amount of work?

To understand this we must again turn to the Norwegian sea, and observe how the ice-melting is conducted in nature. Between Iceland and Jan Mayen the polar current pushes forward great masses of drift-ice during spring and summer. This drift-ice is melted in the warm water carried thither from the eastern part of the Norwegian sea. On p. 288 of my former paper are represented two maps, showing the position of the ice border in this region of the sea in the year 1896. The first map gives the situation in spring in the month of May. The second map shows the situation in July, when the ice border had receded because of the ice melting.

From May to July an ice-field of about 200,000 square kilometres extension had been melted. In reality, however, the bulk of ice melted has been much greater, perhaps three or four times more extensive than the field in May, for as the ice melts the polar current continues to push forward new masses. Part of this ice, of course, is melted by the heat of the atmosphere, but as seven-eighth parts of the ice is submerged below the surface, the incomparably greater part of melting must be carried on below the water surface and at the cost of the heat of the water.

To melt an ice-field in the northern seas it is necessary that at least seventeen times its weight in salt water should be cooled and sunk to the bottom.* The sinking of this cold water resembles a waterfall more than 1000 metres in height. Like any waterfall on the Earth's surface, this submarine fall can produce work, that is, it can work the deep currents in the ocean. It is the power of this waterfall that presses up the wall of cold water north of the Iceland-Färoe ridge (see Fig. 3 on p. 280), as it is the sinking cooled water in the southern ice sea and at Newfoundland that builds up the cold water mountains under the equator and along the coasts of Africa and America (see Figs. 6 and 8). To the question, What becomes of all this sinking cooled water? our answer, as far as regards the Norwegian and polar sea, is, It overflows the rim of the Färoe-Iceland ridge and sinks to the bottom of the ocean, making a fall of almost ice-cold water 400 or 500 metres below the surface. The question, What becomes of this water in the ocean? must be left to future investigation. It is evident that the water must come to the surface somewhere, but where we do not know for certain, for to this hour the Atlantic is hydrographically an unknown sea—a *mare incognitum*.

The sinking of the cooled water whose store of heat has been expended in

* See O. Pettersson: "Die hydrographischen Untersuchungen des Nordatlantischen Ozeans, 1895-1896" (*Petermanns Mittheil.*, 1900, I. and II.).

melting the ice is identical with a waterfall, the effects of which are recognizable in the movement of the bottom layers and submarine currents. The second movement of the ice-melting, *i.e.* the rising of the melted ice-water to the surface, may also be likened to a waterfall, though in inverse direction, for here the water is *lifted from below to the surface*. This too is a production of labour which is made useful in the oceanic circulation, *i.e.* for working the surface currents of the sea, for instance, the polar current. I have estimated the labour thus produced during the ice-melting in summer between Iceland and Jan Mayen as equal to the work produced by a waterfall on the Earth's surface of about 400,000 H.P. These figures represent the energy which drives the water of the East Iceland polar current towards the Färoes. Incomparably greater is the energy produced by the melting of the Antarctic icebergs in the south polar sea. There the melted ice-water rises from a far greater depth, from the undermost side of the icebergs 200 to 500 metres below the surface. As the effect of a waterfall is proportionate to the height from which it falls, it is easy to estimate that every kilogram of ice melted in this depth will produce an energy equal to 7 kilogrammetres.

To get a correct idea of the importance of the ice-melting as a force for working the oceanic currents, we must bear in mind the distinction between *force* and *energy*. Force is possibility for work, but it is not work till an outside energy arrives that can produce work by setting free the force.

An iceberg floating in the sea contains in itself such a possibility for work. It produces a depression in the surface which would be eliminated the moment the ice was taken away. The surrounding water strives to assume a horizontal surface by eliminating the depression occupied by the ice. The water presses the ice upwards, but as long as the ice forms a solid block, its efforts are in vain. The weight of the ice equals the lifting power of the water, which power is localized in the very surface of contact between the ice and the water, but which is unable to produce labour. If heat is brought from outside melting the ice, its molecules will become movable and lifted up to the surface where the melted ice-water flows out, in the shape of a surface current. This, then, is *work*, by setting free the forces that were tied in the contact surface between the ice and sea-water.

Possibilities for such transformation of one energy into another are always present in surfaces of contact where two different substances border on each other. Some such instances may be quoted.

Example (*a*).—Put a solid salt, for instance, common salt or copper vitriol, into a basin of water. Part of the salt will dissolve in the water. The surface of contact between the salt particles and the water is the site of forces endeavouring to drive the salt-molecules into solution. These forces we call the *dissolving tension* of the salt. It drives the salt molecules to dissolve till the water is unable to absorb more or till the solution is saturated with salt. Then a state of equilibrium will arise, because the salt-molecules in the solution set up a counterpressure, which we call the osmotic pressure, against the dissolving tension. If heat is applied from outside, then in most cases the dissolving tension of the salt will be increased so that the equilibrium is disturbed and more salt is dissolved.

Example (*b*).—On the surface of the solution, which is in contact with the air, other forces are active, viz. the vapour tension of the solution which endeavours to spread the water-molecules into the air as vapour. But the formation of vapour from the surface of the solution is counteracted by the vapour tension in the atmosphere. If the solution is heated, the equilibrium between the water-molecules in the atmosphere and in the liquid is disturbed, the vapour tension increases, and new vapour is formed, which must gain room for itself in the atmosphere by displacing a certain volume of air. This is *labour* effected in the manner that some of the

heat energy applied has been transformed into energy or labour in the surface of contact between the solution and the atmosphere.

Example (*c*).—In the surface of contact between two metals, or between a metal and a liquid (electrolyte), exist forces that can generate electric currents, and therefore are called electromotive forces. The pressure or tension effected by these forces we measure in electric units, in volts. If a chemical reaction can take place between the metal and the liquid, the thermochemical energy is transformed into electric energy at the surface of contact, if a passage for the electric current is opened.

Example (*d*).—If two bars of different metals are soldered together, for instance, an iron and a silver bar, and one of the bars is heated, the heat will travel unchanged, that is, as heat energy, through the metal till reaching the junction of both metals. There part of the heat is transformed into electric energy, if a passage for the electric current is opened.

Generally speaking, energy passes through a homogeneous substance unchanged till meeting a surface of contact, where it acquires possibility to transform into a different form of energy. Such is the case with the energy that works the oceanic circulation.

The sun is the source of energy. As long as the energy does not encounter a surface of contact, it passes on its way without effects. In eight minutes the radiant solar energy traverses the distance between sun and earth. At the border of the atmosphere it encounters the first surface of contact, viz. between space and the atmosphere, offering possibilities for its transformation. The surfaces of contact consist of the different layers in the atmosphere, clouds, mist, and dust-particles suspended in the air.

Next, the sun-rays encounter the surfaces of contact belonging to earth and sea. If the earth is covered by vegetation, then every blade of grass, every green leaf, will offer a surface of contact where forces are waiting to be liberated. It is the forces of organic life that, under the influence of the sunlight, build up the cells of the plants. If the sun-rays encounter the sea, then in every drop of water there are similar possibilities for the transformation of energy into the development of planktonal and the microscopic vegetal world of the sea-water. Also in the water itself slumber forces ready to be awakened: the tendency of the water-molecules to transform into vapour. The solar energy promotes this tendency by itself becoming latent heat in the vapour in the atmosphere. *Part of the solar energy, however, will remain in the sea-water as heat, and be carried with the great ocean currents, such as the Gulf Stream, the Agulhas Stream, etc., to the north and south polar seas, where one more surface of contact awaits them*, i.e. *the surface of contact between ice and sea-water.** The heat promotes here the tendency of the ice-molecules to

* There is nothing surprising, from a physical point of view, in the fact that the greater part of the transformation of heat in the ocean is localized to those regions where the polar ice melts in the warmer currents arriving from the tropical parts of the sea. In every hydrographical section through any part of the ocean in which deep soundings have been executed after modern methods, and the results computed after the standard introduced by the International Investigation of the Sea, we are now able to delineate and measure in c.g.s. solenoids the acting forces of the circulation with the aid of Bjerkne's formulæ and Bjerkne's and Sandström's tables. The first results obtained for the Atlantic and Indian ocean are published in 'Svenska Hydrografisk Biologiska Kommissionens,' Skrifter I. and II., Göteborg and Berlin (Springers Verlag). A closer inspection of the diagrams drawn by Sandström in his supplement to my paper, "Ueber die Wahrscheinlichkeit von periodischen und unperiodischen Schwankungen in dem Atlantischen Strom," shows that the c.g.s.

transform into water, and the heat energy itself is transformed into energy of labour working the oceanic circulation, when liberating these forces.

The remnant of the solar energy, when this transformation is completed, is reflected into space, and becomes lost to the earth's heat-store management. Arrhenius suggests * the possibility of still another transformation of the vanishing solar energy. Nature has only one more surface of contact to set against it, viz. the nebulæ which surround the visible part of space with a luminous veil of cosmic dust. Here for the last time the energy may be sifted.

Oceanography is not called on to follow the energy current that passes through the world so far as to the portals of the Milky Way. It aims at accounting for the transformation to which it is subject on its way through the sea, and this is the most interesting task set for oceanography. For the movements of the sea constitute simply a circulation of waters between surface and bottom and between the tropics and the polar seas. Every water-particle that travels polewards is corresponded to by another travelling towards the equator, and is in itself nothing but a vehicle for an invisible reality, the energy, which has another destination.

The Influence of Ice-melting upon the Chemical Constitution of Sea-water from the Atlantic and Indian Oceans and the Antarctic Sea.

The question naturally arises, how far the ice-melting in other parts of the ocean can influence the quantitative relation between the chemical constituents of sea-water. We can ascertain that in two ways, either by studying the relation of S_{Cl} to $S\sigma_0$, as the Norwegian chemists have done, or by accurate determinations of the relation of SO_3 to Cl.

At my request Miss E. Pettersson, in Stockholms Högskolas laboratory, executed a series of analyses of the latter kind on waters from the Atlantic and Indian oceans and the Antarctic sea. The water-samples were taken by the officers of steamers running between England, the Mediterranean, and India. In order to get general results, the samples from a certain part of the ocean, *e.g.* from Brittany to Gibraltar, were mixed together and filtered before the analysis. In the same manner a number of water-samples taken by O. Nordenskiöld on his Antarctic expedition were selected and analyzed. The amount of halogen was determined as usual by titration after Knudsen's method, the sulphuric acid (in weighed samples measuring about 153 c.c. each) in the manner employed by Schmelck and Hamberg, the weighings being reduced to vacuum and all precautions taken to ensure complete uniformity in the operations. Two chlorine titrations † and two analyses of sulphuric acid were made on every water. The chlorine titrations gave in every case identical results.

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solenoids are crowded together especially under the 40–50th lats. north and south, where the influence of the ice-melting prevails. The mechanism of oceanic circulation can be resembled to that of a pumping-engine, of which the boiler is placed in the tropical and the condensers and cylinders in the Arctic and Antarctic regions of the sea.

* 'Lehrbuch der kosmischen Physik,' 5, p. 232.

† The density σ_0 of the waters was not determined, because I feared that the results would be misleading on account of the possibility that some of the samples, which had been preserved in glass bottles more than a year, might have taken up Na_2SiO_3, etc., from the glass.

Locality temperature.		Cl per mille.	SO_3 per mille.	$\frac{100\,SO_3}{Cl}$	Depth.
North Atlantic ocean, eastern part, Bretagne — Gibraltar. Oct. 1902 and Feb. 1903	11°·5–19°·7	19·89 19·89	2·264 2·268	11·38 11·40	Surface.
Indian ocean, Aden—Ceylon. Oct. 1902 and Jan. 1903	22°·6 –29°·58	20·09 20·09	2·290 2·289	11·40 11·39	"
North Atlantic ocean, 32°–26° N. lat., 19°–21° W. long. Nov. 1901	20°·98–22°·42	20·50 20·50	2·339 2·347	11·41 11·44	"
Antarctic sea, Jan.–Feb. 1902, 63°–66° S. lat., 44°–55° W. long.	under 0°	18·50 18·50	2·119 2·117	11·45 11·44	Depths from 0–40 metres.
Antarctic sea. Jan. and Feb. 1902, *ibid.*	under 0°	18·48 18·48	2·094 2·110	11·33 11·41	Depths from 10–400 metres.

In the Atlantic and Indian oceans there seems thus to prevail a greater uniformity in the chemical composition of the waters than in the Norwegian and Arctic seas. The uniformity is far greater than we could expect from some analyses of Atlantic waters recently published by M. Thoulet and some of his assistants. The great differences between S_{Cl} and S_{σ_0} * found by these hydrographers have, however, been found not to exist by subsequent analyses, made by Mr. Allemandet at the Oceanographical Museum in Monaco and by Mr. Robertson of the Scottish Hydrographic Commission in Dundee, and must depend on analytical errors. The same may in some degree also be the case with their estimation of the ratio SO_3 to Cl. We know, however, too little concerning the Atlantic on the whole to express any opinion about the chemical properties of its bottom water, which must be a matter of future investigation. With regard to the upper layers, the table shows that the influence of the ice-melting is felt also in the chemical composition of the Antarctic surface waters, which show the highest value of the ratio SO_3 to Cl = 11·45, while the water some hundred metres below the ice has the lowest value = 11·33 or 11·41. The corresponding values in Hamberg's analyses of the surface water of the Arctic polar current at 63° N. lat. and 40° 35′ W. long. and the underlying water are 11·51 and 11·46 or 11·48.

The mean value for the oceans found by Dittmar † = 11·576 or by Schmelck = 11·46 cannot be compared directly with the numbers given above, on account of the different standard (chlorine determination) to which they are referred.

* 'Résultats des campagnes de la Princesse Alice en 1902–1903,' xxix. Such differences, if they existed, would in fact reduce the value of the Hydrographische Tabellen edited by Knudsen almost to *nil*. M. Thoulet advocates the principle that every water-sample which can be gathered from the ocean has its own "individual" physical and chemical properties. Theoretically this may be correct, since the vegetable and animal life involves chemical processes which must exert an influence upon the surrounding water, but such changes are too subtle to be traced by the means of analysis hitherto applied. Practically Thoulet has exaggerated the differences in the chemical composition of sea-water existing in nature tenfold. This is a practical question—a question of limits, not of principles.

† 'Chall. Reports: Physics and Chemistry,' pp. 138 and 233.

Hydrographers have long endeavoured to trace the origin of sea-waters from their chemical composition. The investigations here referred open a new way for the study of oceanic circulation, and show that the influence of ice-melting upon the constitution of sea-water can be ascertained by chemical analysis. On the other hand, the high degree of uniformity which prevails in the chemical composition of sea-water bears witness of the intensity with which the circulation is upheld in all regions and in all niveaus of the sea. The ice-melting process is one of the most powerful agents of nature in that respect. The waters which have contributed to the melting of the ice sink, on account of their increased density, to the deepest recesses of the oceans, to which the influence of the winds and the tides never reaches.

Hydrographers will do well to bear in mind the recommendation of the Conference of Stockholm—

"*The chemical analysis shall be controlled by physical methods, and the physical determinations by chemical analysis.*"

The determination of salinity by chlorine-titration must be checked by determinations of the density. In all ordinary cases, both determinations will lead to identical results $S_{Cl} = S_{\sigma_0}$. Whenever a discrepancy is found, it is a sign that some problem of interest to hydrographers is in sight.

Concluding Remarks.

The theory of the influence of ice-melting upon oceanic circulation, of which I have tried to give the outlines in this and in a foregoing paper (see *Geographical Journal*, vol. **24**, 1904, p. 317), has had the advantage of attracting the criticism of hydrographers. Expeditions have been started in order to test certain of the statements made, and scientific papers have been published in order to disprove them. To the last publication of this kind which has appeared, 'Northern Waters,' by Nansen, I am indebted for the elucidation of one point of cardinal interest for my theory, viz. the discovery of the discrepancies between the quantities S_{Cl} and S_{σ_0}, which exist in the deep waters of the Barents and the Norwegian seas. It seems well-nigh impossible to find any other explanation of the fact that "the analytical determination of chlorine gives comparatively high values of salinity near the surface, but comparatively lower salinities for the deeper water of the Barents sea" ('Northern Waters,' p. 11); or that $S_{\sigma_0} > S_{Cl}$, both in the surface water of the polar current east of Greenland, and in the deep water of the Norwegian sea. Nansen, at least, has not given any such explanation.

However useful this opposition against the ice-melting theory has been for its development, I think it is time now to sum up, not only the arguments used against the theory, but also the points in which Nansen and I seem to agree.

I. The intermediary layer of relatively warm and saline water found by the *Ingolf* expedition at about 60 metres' depth under the waters of the polar current between Iceland and Jan Mayen, and by Captain Ryder north of Jan Mayen at 200-300 metres on the slope of the eastern coast bank of Greenland, are, according to the ice-melting theory, an indraught from the Atlantic warm-water current at the opposite side of the Norwegian sea. It was first believed that this warm-water layer derives from an under-current which enters the Denmark strait from the Irminger sea. In his paper on the oceanographical results of the expedition with Michael Sars in 1900,* Nansen, however, admits that "whether the underlying warmer water in this case (between Jan Mayen and Iceland) comes from the north

* See p. 156.

or west, or from the south or south-east, is somewhat difficult to decide at present, though the latter may be most probable."

Concerning the intermediary warm-water layer north of Jan Mayen, Nansen says in his last paper, 'Northern Waters,'* "at any rate, the warm water underlying the East Greenland polar current must come from the Atlantic current (Gulf Stream) running north along the eastern margin of the deep basin of the northern Norwegian sea; and somewhere to the north of Ryder's, Nathorst's, Amdrup's, and Amundsen's stations it must come from the east by a partially cyclonic movement." Our opinions thus agree about the main fact, viz. that the great Atlantic current of the Norwegian sea sends out branches of warm and salt water as under-currents westward both south and north of Jan Mayen, which penetrate under the polar current as far as to the coastal banks of Greenland.† The main features of the current chart which I have schematically designed in Fig. 4 can thus be taken for granted. Difference of opinion still exists regarding the direction of the northerliest branch of these under-currents, which I have traced north of Jan Mayen from Östergren's and Åkerblom's deep soundings and from the calcareous deposits of the bottom in that part of the sea,‡ while Nansen and others imagine that the warm water found at 100–300 metres on the Greenland coast bank belongs to a south-going under-current, which makes a circuit along the coast of Spitsbergen and North-Eastern Greenland, crossing the entrance to the polar basin. This question must still be left open. According to my view of the matter, we have in the western part of the strait, between Spitsbergen and North-Eastern Greenland, the exit from the polar basin. This region of the sea is probably occupied from the surface to the bottom by Arctic water, which leaves no thoroughfare for a warm under-current from the east, *i.e.* from Spitsbergen. The experience from Peary's last expedition shows that the ice and waters of the western part of the polar basin, or the region of the s.c. palæocrystic ice, are moving towards this passage. The outflow from this exit of polar waters is characterized by the lack of an intermediary warm-water layer which is found almost everywhere in Arctic regions, and its surface is marked by a protruding tongue of icefloes, while bights of more ice-free water are found east and west of it, where there exists an intermediary layer or under-current of relatively warm and salt water. Captain Amundsen's stations XIII.–XVI. are situated § within the southerliest part of this truly Arctic region in 73°–75° N. lat. and 3°–4° W. long. Amundsen's stations XVII., XIX., XX., XXIII. are on its western limit at 74° lat. and 6°–7° W. long. In these stations there are found some feeble signs of a temperature maximum at 60–100 metres, while in the former stations XIII.–XVI. the temperature is uniformly under −1° from 20–50 metres to the bottom.

West of this region we have Ryder's ‖ stations and Åkerblom's ¶ station VI. at 73° 47′ N. lat. and 6° 22′ W. long., and VII. at 74° 38′ N. lat. and 15° 3′ W., with a well-marked temperature maximum of up to +0°·71 C. at 200–300 metres.

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* *Loc. cit.*, p. 76.

† Nansen, of course, still maintains his opinion that the presence of these warm under-currents has no influence upon the melting of the ice of the polar current.

‡ Fig. 6, p. 293, *loc. cit.*, *Geog. Journ.*, vol. **24**, No. 3.

§ 'Northern Waters,' pp. 141, 143. Amundsen's station **XVI.** in 74° 48′ N. lat. and 4° W. long. is the typical representative of the hydrographical conditions of this region.

‖ Ryder and Rördam, 'Hydrografiske Undersögelser, Meddelelser om Grönland,' **17**, p. 286. Köbenhavn: 1895.

¶ F. Åkerblom, 'Recherches oceanographiques,' pp. 25, 26. Ups. Univer. Arsskrift: 1903.

East of it we have Östergren's station in 77° 11′ N. lat. and 0° 55′ W. long., where the maximum at 100–200 metres exceeds +1° C. Still more eastward we meet the core of the north-going Atlantic under-current, with its maximum of +2°·63 C. and 35·29 per mille at 200 and 400 metres (Arrhenius' station).

II. In Nansen's former memoir, 'The Oceanography of the North Polar Basin,' this part of the Arctic sea was described as an almost secluded region characterized by extraordinary hydrographic conditions. Geographically, it was separated from the Norwegian sea by a submarine ridge at a depth of 300–800 metres. Over the top of this ridge flowed the under-current of Atlantic water. Above this water from 200–250 metres was a layer of "true polar water" of about 34·40 per mille salinity, which at 60–80 metres showed a minimum of temperature of −1°·8 to −1°·9 C. This is the point of equilibrium of ice and Atlantic water. Nevertheless, Nansen declared the low temperature of this water, in which the polar ice floats to derive, not from contact with the ice, but from the cooling influence of the atmosphere in some unknown part of the polar basin, from which the water was supposed to be an indraught.

Below the Atlantic under-current was another kind of water of a temperature below zero which filled the polar basin from the bottom to the level of the ridge. This water was also supposed by Nansen to have been cooled down to its present temperature in some unknown region by contact with the atmosphere. Between the deep water of the two adjacent deep basins of the polar sea and the Norwegian sea there was little or no communication, and the main feature of the hydrography of the polar sea was that its water had a considerably higher temperature and salinity than the water-layers at corresponding depth in the Norwegian sea (−0°·9 C. and 35·16 per mille instead of −1°·3 C. and 34·93 per mille). My objections to these conjectures are noted in my former paper upon the influence of ice-melting, and need not be repeated, since Nansen's views at present seem to be more in concordance with my explanation—at least, in some important respects.

Concerning the temperature minimum in the upper layer at 60–80 metres, he, upon closer consideration, comes to the result "that Prof. Pettersson's suggestion that this temperature minimum may be due to contact between the sea-water and the ice seems very probably true, although, according to the direct observation made (*e.g.* measurements of the height of the same hummock during a long period of many months), Pettersson is not right when he assumes that an appreciable melting of the ice may be produced by this contact in the north polar basin."

The ice-melting process in the polar basin is naturally a slower one than in the Norwegian sea, on account of the restricted supply of warm Atlantic water, which, moreover, is separated from the ice by the cold upper layer. Nevertheless there exists a gradient of temperature from the Atlantic water of +1° C. and thereabout to the minimum region of −1°·9 C., 150 or 200 metres higher up, which must steadily act in favour of the melting of the undermost part of the ice-floes, which are piled upon each other unto that depth by the screwing of the ice-fields.

Another and more effective agent is the motion of the submarine waves or undulations, which, according to Nansen, stir up the boundary layer between the Atlantic water and the overlying cold water. The amplitude of such boundary waves between two media of nearly equal density can attain a magnitude of 50 to 100 metres and more.

III. With regard to the deep water of the polar basin, Nansen still maintains that its temperature must be higher than that of the Norwegian sea, and cannot, on any account, be lower than 0°·9 C. In his estimation of its salinity he is, however, prone to make a reduction from 35·14 per mille to 34·94 per mille. After

that there is no necessity to uphold the hypothesis of a high submarine ridge. He says,* "This ridge, if it exists, must in that case be very low, rising perhaps to depths where the bottom water of the northern Norwegian sea between Spitzbergen

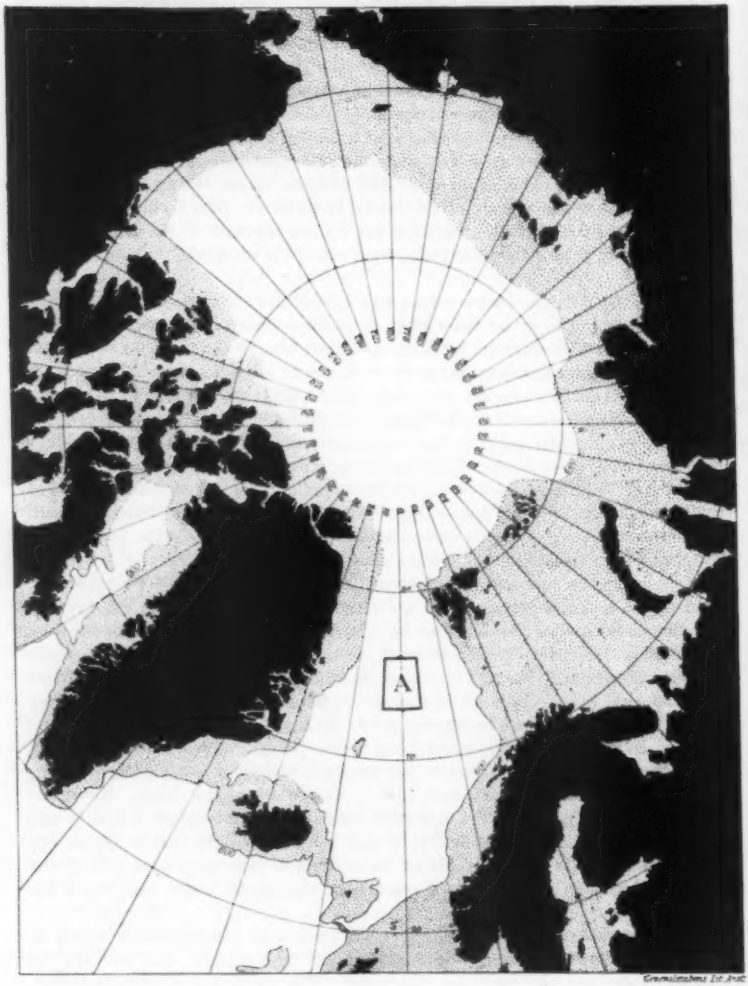

FIG. 9.—NORTH POLAR CHART.

and northern Greenland has a temperature of $-1°$ C. This low ridge would then prevent the coldest bottom water of the deepest basin in the Norwegian sea from running into the north polar basin. It has, however, been seen that the bottom

* *Ymer*, 3, 1900, p. 325.

water is probably heated from about −1°·3 C. to about −1°·1 C. on its way from 74° N. lat. to the southern part of the Norwegian sea. And a similar heating must be considered likely on the much longer way through the north polar basin, which must be considered as like a great fjord, where movement of the deep water is extremely slow. The higher temperature is therefore no hindrance in the way of assuming that the bottom water of the latter is the same as that of the Norwegian sea."

Nansen imagines that this bottom water is produced by the cooling influence of the atmosphere in winter upon the surface water of the Norwegian sea in the same region where Captain Amundsen's stations are situated,* viz. between 73° and 76° N. lat., and 4° W. long. and 4° E. long. This is the spot marked with the letter A in the chart (Fig. 9). The chief difficulty of this explanation lies in the fact that the bottom water of the Norwegian sea has a temperature of −1°·3 C. and a density *in situ* of 1·02811. If water of so high density has acquired its low temperature from contact with the cold air, it remains to show in what part of the Arctic sea this takes place, *i.e.* where such water exists as surface water. Hitherto no water of this kind has been found, the surface water of the polar basin and the polar current at the eastern side of the Norwegian sea, as well as the Gulf Stream water at the eastern side of that sea, being both warmer and of less density than the water in question at all seasons. Still, Nansen believes that in the region indicated there exists, during some months of the year, water of the named temperature and density at the surface.

The area denoted by A in this chart would consequently, during some months every year, act like an open window, from which water, cooled and saturated with atmospheric gases, would sink down to the bottom of the Norwegian sea, where it would flow northwards over the hypothetical ridge into the depth of the polar basin and southwards towards the southern parts of the Norwegian sea. "During this circulation (which takes place so slowly that the water has spent perhaps fifty years on the distance from 73° N. lat. to 64° north of the Färoes), it is very slowly heated from the underlying warmer bottom, and also slightly from the over-lying warmer water, chiefly by convection. In this manner its temperature near the bottom is gradually raised from about −1°·3 C. to about −1°·1 C., and perhaps −1° C."†

Hydrographers will have to choose between this hypothesis of Nansen and the explanation given in this and the preceding paper on the influence of ice-melting upon oceanic circulation. In so far I agree with Nansen, that *if* water of so high density as 1·02811 can exist at the surface of the sea—which is not proved yet—it must be sought for in the region denoted with A in the chart, where the conditions are remarkably uniform from the bottom to the surface with regard to temperature and salinity. But I cannot admit that the circulation of the waters in the deep parts of the ocean is a slow process. Under the surface of millions of square kilometres occupied by the Arctic ice of the polar basin and the polar current, thermic forces are at work which incessantly send down cold water to the bottom of the sea. The flow of this cold water is intercepted by the submarine banks between Greenland and Scotland, where it accumulates to a cold wall some 300 to 400 metres higher than the level of the bank, over which it escapes into the depths of the Atlantic ocean.‡

Before the paper, the PRESIDENT: We have met here to-night for two purposes, related to each other. The first is to tender our cordial welcome to the members

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* *Loc. cit.*, pp. 69, 92.

† *Loc. cit.*, p. 92.

‡ A communication from Captain Tizard criticizing Dr. Pettersson's paper will be found on p. 339 of the present number.

of the International Council for the Study of the Sea, who have honoured us with their presence here to-night. I shall not enter into details about the work that they are doing. I would not rush in where angels might fear to tread. It is a very technical subject, and after Dr. Pettersson has read his paper there will be a general discussion, in which, I hope, the members of the International Council will take part and give us some idea of the practical results that have been attained, or that they hope to attain, from their inquiries. But I think that you will expect me to say a few words as to the general objects and the history of this International Council. Towards the close of the last century a certain number of experts urged that there should be some scientific treatment of the question of the fisheries, especially in the northern seas. Preliminary conferences were held by delegates of nine Governments—Russia, Finland, Sweden, Norway, Denmark, Germany, Holland, Belgium, and Great Britain—first at Stockholm in 1899, and then in Christiania in 1901, and a bureau was organized, which does its work at Copenhagen. The International Council met for the first time at Copenhagen in 1902, and they are holding their latest meeting—I hope not their last meeting—in London in 1907. I say I hope not their last, because there is a question of dissolution of the Council. It is not a subject upon which I can say much, but I think it would be a thousand pities if an international arrangement of this sort were brought to a close. The relations between civilized countries are not so absolutely cordial as to justify our terminating any form of co-operation. The general object pursued by the Council is an inquiry into the physical conditions of the sea, particularly as regards its varying degrees of saltness and temperatures, which so closely concern the fisheries. I am trying to avoid the word "fish." I dare say you remember that in diplomatic circles there has been a grave question for many years as to whether a lobster is a fish, and I understand that the International Council do include crustacea in their inquiry. Let me just point out here that theirs is a strictly geographical inquiry. We have had lately some high educational authorities asking "What is geography?" and, like jesting Pilate, they have not always waited for an answer. But we hold that geography is concerned, as one of its branches, with the distribution of anything that may exist on the surface of the globe. I suppose it will hardly be contested that the sea forms an important part of the surface of the globe, so that the distribution of fish or crustacea is a geographical question, and that is why it is we have been able to claim the privilege of entertaining to-night the members of the International Council for the Study of the Sea and to introduce them here to the Fellows of the Royal Geographical Society.

So much for the first purpose for which we have met here to-night. The second purpose of our meeting is to listen to an address on the "Influence of Ice-melting upon Oceanic Circulation," which is to be delivered by Dr. Otto Pettersson, of Sweden, who is, as I have no doubt you know, vice-president of the International Council of which I have been speaking. This, of course, is also a geographical question. I shall not attempt to forecast what Dr. Pettersson will say, but I am sure we shall listen to him with the very greatest interest. I now invite him to address you on "The Influence of Ice-melting on Oceanic Circulation."

After the paper, the PRESIDENT: I rise to propose a cordial vote of thanks to Dr. Pettersson for his address. You will have realized the difficulty with which he had to contend in trying to compress into a short time the immense mass of information he has collected. We are much indebted to him, and your applause expresses your thanks for his interesting address. We have another pleasure to-night, as I pointed out to you earlier, and that is to hear the remarks from other members of the International Council for the Study of the Sea. Any thorough discussion of Dr. Pettersson's paper is, of course, impossible; the subject is too

intricate to discuss at a meeting like this, although I do not wish to preclude any one from speaking on the paper who desires to do so. I call upon Norway first to reply, because it is represented by an Honorary Corresponding Member of ours, whom we have often heard before and always wish to hear again, His Excellency Dr. Nansen.

THE INTERNATIONAL COUNCIL FOR THE STUDY OF THE SEA.

Dr. NANSEN: The President has done me a great honour by asking me to make some remarks upon the work of the International Council for the Study of the Sea, a work which has now been carried on for nearly five years, and which we all hope is going to be carried on for a great many more years in the future. The goal of the whole inquiry is, of course, a scientific exploration of the sea, but it has more than a purely scientific aim; our purpose is especially a thorough investigation of the sea, with regard to its various conditions influencing the life of the food-fishes that are important for the nourishment of man. I believe it may be said that our work has been very successful in that respect, and that very important results have already been attained; but this is not for me to go into—more competent men will mention this part of the work later. I would rather say a few words about our physical investigations, which, we hope, will in due time give us a satisfactory understanding of the circulation of the sea, a problem of the greatest importance for the final solution of most other problems connected with the sea. Our observations are in several respects throwing entirely new light on this difficult subject. The vice-president of the council has given you some examples to-night of the physical work which has been carried on. I am sure many of us do not quite agree with him in various points as to the correct explanation of the observations made, but this would not be the place to go into details in this respect; and especially not for me, as I have recently published a paper on it, which Prof. Pettersson has quoted, where I have laid down my own views of the circulation. But in order to give you some idea of the results attained with regard to the circulation of the sea, I should like to show you a lantern-slide demonstrating the circulation in the Norwegian ocean according to the Norwegian investigations of it. It may be good, of course, for more popular representation, to draw charts of the sea-currents like those of Prof. Pettersson's, but they are apt to give misleading ideas about the currents, as people will often speak of them as though they run like rivers through the ocean. The circulation of the sea has, however, no resemblance whatever to rivers; it means the continuous movement of the whole water-masses from the surface to the bottom, and over the whole area of the sea, and we cannot move the water-masses in our part of the sea without moving all the rest. Mr. B. Helland-Hansen and myself have been working up the results of five years' investigations in the Norwegian sea, which is, I am sorry to say, the only part of the ocean which is really well-known, and where we can say something with certainty about the circulation. We hope soon to publish our results, but here I show you a chart of the circulation based on our investigations. You will see that the water has a certain tendency to move in greater and smaller vortexes and whirlpools, and you might, in fact, consider the whole circulation of the ocean as a series of such movements, which, to a very great extent, move in the cyclonic direction. You will see the Atlantic current or Gulf Stream comes into the Norwegian sea, between the Faeroe islands and the Shetlands, and at once it begins to make whirlpools in a most remarkable way by meeting the colder current coming from the north-west past Iceland and the Faeroes, as is proved by the Scottish observations made during four years. I may make the remark here that, according to my view, the chief cause of the circulation of the sea is the combined effect of the cooling of the water

and of the winds. I do not believe that ice-melting has much importance in this respect; I think it has practically no direct effect upon the cooling of the sea, because the ice is formed and melts in the same sea, and the heat which is disengaged the moment the ice is formed is again engaged by the melting process, so the direct cooling effect of these processes is *nil*. Indirectly the formation of ice in the sea has, however, the opposite effect, as the ice-cover protects the underlying water from being cooled by radiation of heat. If, therefore, we had an open North Polar sea instead of an ice-covered one, we should get a milder Arctic and North Polar climate, but a much more cooled sea. But let us return to the Norwegian sea. We see that along its eastern side the warm Atlantic water runs northward, whilst along its western side, the Greenland and Iceland side, the cooled polar and Arctic waters run southward. In the southern part of the Norwegian sea, south of the latitude of Jan Mayen and northern Norway, these currents form a great cyclonic circulation of the whole water-mass, with many smaller vortexes or whirlpools, especially prominent along the western side of the Atlantic current or the so-called Gulf Stream. In the northern part of the Norwegian sea there is probably another similar cyclonic circulation. In the Barents sea there is also such a cyclonic movement of the waters, with many similar vortexes. This chart may possibly give you some idea of the object of the physical part of our work. It is trying, first of all, to give us some solid reliable information of the circulation of the ocean—what its currents really are. But this is not the final object. The further object would be to find the variations in the circulation, because it is evident that these variations have great and far-reaching effects upon various other conditions of the Earth, and are of very great importance to humanity. First of all, it has a very great effect on the *climate*. If we can master the variations of the circulation of the ocean, we shall probably also master important features in the variations in our climate. That is a goal which is still far in the future, but we may hope to reach it some day. On the other hand, it is also evident that these physical conditions are of very great importance to the biological conditions of the animals living in the sea. And when we find, for instance, that the quantity of fish vary much from one year to another, it is not unnatural to think that the cause might be found in variations in the physical conditions of the ocean. The lack of fish in one year may be due to the fact that some years earlier there were certain conditions in the sea which were unfavourable for the reproduction of the fishes. You will thus see that a thorough understanding of the physical conditions of the ocean is of very great importance, not merely scientifically, but also for the fisheries and to practical meteorology. I wish, therefore, to impress upon you the necessity of the nations co-operating in order to make the sea a known part of the globe; we can no longer allow it to remain an almost unknown world, as it is at present.

The PRESIDENT: I think, in view of the visitors who are now in England, whom many of us have seen to-day—I mean the royal visitors—I must call next upon Denmark to speak. Will Dr. Petersen kindly reply on behalf of Denmark.

Dr. PETERSEN: I am not prepared to speak here to-night about this matter, having had very short time to think about it; but if you will allow me, I will speak a little about marine biology. I am a marine biologist myself, and have spent my life in this branch, studying marine fishes, not only from a scientific point of view, but also from an economical view, with the idea that science will conquer this ground too. We know in Denmark what science has done for agriculture, and I hope that science by-and-by will do the same for the sea. Time will not allow me to make a long speech about the whole of the scientific work done in marine biology, but, if you will allow me, I will give you some few examples of the methods and of the results we have obtained. We in Denmark, many years ago, tried to

label a number of fish for the purpose of finding out where the fish migrated to. This method has been employed for flat fish, especially for plaice. We fastened two bone buttons together with silver wire through the plaice, and they were thrown overboard alive; when the fishermen caught them again they told me where they caught them and when, and in that way we found out where they migrated to, and how much they had grown. This method was used by me many years ago, and it has given interesting results. I mention it because it has been in use in all the co-operating countries. I once took three hundred plaice and labelled them, and put them back into the Kattegat. One-third of them were caught after they had been in the sea three months; I never expected to see any of them again at this my first trial. We have made many better investigations and trials afterwards, and we can now give a good report for the different waters. So far as I can remember, 60 to 70 per cent. of labelled plaice in the Kattegat are caught and sent to me in a year. In the North sea the percentage is about 50 per cent. We can learn a great deal from these methods, and I hope the time will come when we shall have learnt enough about the North sea to get a special law for undersized plaice. I should like to say a few words about the results of the investigations of the common eel. Denmark is a very little country, but you will remember that we must go to Iceland and Greenland too—we have only one ship, but it has been round Iceland, in the neighbourhood of Greenland, and it has been in the neighbourhood of Spain also. It looks, perhaps, a little peculiar that we in Denmark are sailing so much in the waters of other nations, because we have made it a common rule that each country shall deal with its own coast. It was a special problem which caused us to go so far. The work on one of these voyages was to find the larval eel. One specimen was first found west of the Faroe islands. Next year the ship went along the west coast of the British Isles, west of Ireland, specially to find some more of these larval eels; and we found a lot, especially south-west of Ireland and off the coast of France and Spain. Therefore we have come to the conclusion that the eels do not breed in the North sea, because their larvæ (*Septocephalus*) are not to be found there. Therefore, all the eels grown up in Sweden, Norway, Russia, Germany, England, and Holland, of course, must go westward in the very ocean to breed. We hope by means of these investigations to be able to improve our eel fisheries. We intend to catch, as far as possible, all the eel from the whole Baltic on the migration to the breeding-places; we have during this to go through the narrow ground near Copenhagen. We hope to be able to stop them there each autumn. I mention it here because knowledge about such a thing as the breeding of the common fresh-water eel has supplied us with the knowledge of how to legislate for the whole eel fishery.

The PRESIDENT: I will ask next one of the representatives of Germany to speak.

Dr. OTTO KRÜMMEL: When we held our first meeting at Stockholm in 1899, our knowledge of the seas bordering northern Europe was still very incomplete, not only as to the physical properties of the water, but as to the food-fishes also. It may be said that now, after five years' co-operation, we have laid very good foundation in both respects. We know the main features of the currents in the Baltic and the North sea, and we have got an idea as to the causes controlling the very complicated movements of the water in the western Baltic. As regards general biology, we shall soon have, at least in Germany, by our well-approved methods of studying plankton, some definite information on the nourishment which the fish find in their waters. By collecting and counting the fish-eggs floating in the waters, it is now possible to state where the food-fishes have their spawning-grounds. Thus our knowledge of the nurseries of the young fishes is growing also. The discovery made by our countryman, Dr. Reibisch, of the means of determining the age of any

fish by counting the rings formed each year in the otoliths, or ear-stones, was extremely useful. This method has now been extended to counting the more or less opaque stripes in the scales and in the vertebræ of the fishes, as has been carried out in the Heligoland Biological Station, under the direction of Prof. Heincke. Not least, we have arranged for very detailed statistics of the main food-fishes landed in our fishing harbours. As our fishermen have had the intelligence to see that, after all, it would be to their own advantage to lift the secret from the fishing-grounds where they have made their best catches, it is now possible by comparative statistics to clear up the productiveness of the various areas in the North sea. For a nation like the German, now growing every year by 850,000 inhabitants, there is no doubt that a rational exploitation of the bordering seas has become a very serious question of food-supply. We hope that the continuation of the international co-operation as to the study of the sea will bring no less profit to the other nations around the northern seas of Europe.

The PRESIDENT: I will ask a representative of Belgium, Prof. Gilson.

Prof. E. GILSON, of Louvain: The President could not have done better than call in the first place the representative of Norway, the country lying nearest the regions where the phenomena, related to us by Prof. Pettersson, have their principal seat, and the country which has produced men like Nansen, Hjort, and Helland Hansen, who have done so much for their exploration, as also for the study and co-ordination of the results obtained. For reasons of an opposite kind, however, the President might, it seems to me, have called in the last place the delegate of Belgium, which of all the associated countries lies the furthest south, the farthest removed from the regions where the fusion of ices produces its most direct effects, and the country, moreover, the last to enter the field of polar and oceanographic research. No doubt it was his intention to pass from one extreme to the other, and to give me the opportunity to remark to you how the region committed to us in the International Exploration includes in it an interest peculiarly its own. It is, specially, the southern threshold of the North sea, the gate of communication between that sea and the Channel. The importance of this communication is proved to have been often exaggerated. In taking an estimate of it there is occasionally left out of account, not only its narrowness, but also its shallowness, and the direct reversal there undergone twice a day by the tidal currents. These circumstances, taken in connection with other observations, sufficed to draw from your illustrious compatriot, Lord Kelvin, the remark that, supposing the strait came to be closed, that occurrence would hardly affect the circulation of the currents in the North sea. Yet, of however small account it may be, this communication is in very actual operation, and offers much that is interesting biologically. And it is from this point of view that we take its study for our special mission. If, then, little has been done in this way in the past, the attention of the Belgians having been but recently directed to affairs of the sea, we yet hope to obtain useful and interesting results in the future.

The PRESIDENT: I propose next to ask Prof. Weber if he will kindly speak for Holland. I am afraid he must speak in English, for I doubt if there are many here who speak Dutch.

Prof. WEBER: I hope you will excuse me, because I am not able to say anything about any of the original work. I have not personally been engaged upon this work, but I can say Holland has produced the General Secretary, and he will perhaps say a few words about the original work, the measuring of oceanic circulation along our coast.

The PRESIDENT: The General Secretary has refused to say anything. I call on the representative of Finland, Dr. Homén.

Dr. Homén: Finland lies far from the great waters of the North sea and the Atlantic, the scene of the hydrographic phenomena about which we have just been hearing excellent expositions. The peninsula of Finland is washed on the west and on the south by the Baltic sea, and its two gulfs of Bothnia and Finland. These waters, it is evident, do not offer for study problems of equal importance and magnitude with those presented by the Atlantic. An almost closed sea, in which already Wilcke witnessed the quick circulation of the water, the Baltic sea supplies a group of questions such as might abundantly reward investigation. For one item, the powerful Baltic current, the superficial current, namely, of water but slightly saline, issuing from the Baltic by way of the Kattegat and the Skager Rack into the North sea, is of great importance for the hydrography of the latter. In order, therefore, to a complete knowledge of the North sea and its currents, the study of this Baltic current may not be left out of account. The investigation of the hydrography of the Baltic, again, constitutes an important part of the programme for the scientific examination of the seas in the north of Europe.

Quite as much, however, as the purely scientific interest, the desire to improve the fisheries induced the Government of Finland to contribute the means needful for the hydrographic research which has since 1898 been uninterruptedly pursued. It is further hoped that the study of the currents, so dangerous to navigation in our waters, will in future yield results of practical utility. The navigation of our seas in winter is for us a question of great economic moment, and the great difficulties opposed to their navigation by the severe congelation to which they are subject have tended to quicken the interest in the question of scientific research in the Baltic.

The publication of the results of our observations accumulated during the last nine years has been begun. In about three years hence it will, I hope, be possible to form a fairly complete idea of the hydrographic phenomena in the north of the Baltic and its great gulfs of Bothnia and Finland.

The President: The only remaining country, Russia, is not represented here, but I believe Dr. Hjort, Director of the Norwegian Fisheries, can give us some interesting information. If he will kindly do so, we shall be very much obliged to him.

Dr. Hjort: When you do me the great honour to ask me to say a few words here, I must take this opportunity to say a little about the idea which has been in my mind these three years, namely, the question as to how this oceanic work can do anything to advance the life of the fisherman. In the fisheries, as in any other branch of human activity, there are periods of expansion and there are periods of economy; so it has been in the fisheries, as you know. The great time was when the British fishermen not only went out to the North sea, but when, after a while, they went to Iceland, and down to Spain and Africa. When the practical man asks you what is the practical use of science, he mostly wants you to find some new fields for fishery; he wishes to discover new banks in order to let the fishermen get more money and let them be able to introduce a new industry. But science is very seldom able to do that, and everybody who has seen the great British fleets, for instance, at Hull, Grimsby, Aberdeen, or anywhere else, will at once understand that merely scientific systems cannot do very much amongst these clever hard-working people; but nevertheless there are some circumstances when science is able to do a work of that kind, and a great part of my work has been in that direction. When we began our investigations, a great part of the Norwegian sea, while not undiscovered and not uninvestigated by soundings, was never tried by any fishing gear at all. This great field was never tried, and all this big sea was very little studied. We had in Norway fifteen years ago a great number of fishermen, perhaps a hundred thousand, but they had only very small open boats, and they fished

from the shore and never went out to the sea to a great extent, because they did not know the sea. Our great object was to go out and to make fishing experiments on one after another of these great banks, of thousands of square miles. We made fishing experiments, and we gave our charts to the fishermen, telling them where they could go, and we have had the pleasure also of seeing a great number of big boats going on grounds where they have never been before, and instead of only having open boats, we have had the pleasure of seeing these people develop a fleet of about 4500 deck boats, and they now go over all these banks, and also to Iceland, while a few years ago they only stayed close to the shore. In this way it has been possible for science to do this work, but this possibility was only due to the special circumstances of these poor people not having the capital which the people here in England have, the capital which enables us to do much more than a private man can do. But as this fleet advances, and Great Britain and all the other countries along the North sea and along the coast of Norway also advance, there will come a time in Norway, as in all other countries, when it will be difficult to advance the fisheries by expansion, and the question will be what can we do by economy? And that question is the other great practical purpose which we are all going in for. This question of economy can, in my opinion, not be stated in a more clear way than by taking an example from the study of human beings, to take a comparison from the science of the population. As you study the population, by statistics you can see if a people, if humanity, is prospering in the different parts of the world; you can see how long they live; and you can see, for instance, as this great science has shown, that the more civilized the world is getting, the longer the life of the people will be. In this way we are able to study fish also. It sounds very difficult to do this, but it is possible; we are able to tell the age of these most important fishes; we can tell exactly how old every herring, every haddock is; we can say how long they live; and in this way we are able to study the lifetime which they have. I can give you some few examples of this. In the spring time great shoals of fish approach the coast of Norway; we catch, perhaps, a hundred barrels of herring here; we catch millions of cod here; and if we study these very carefully we can see that the swarms come in groups of years. For instance, the herrings come in groups of from three to fifteen years, and even eighteen years in the open fisheries here. We can see that other fish are from four to eighteen or twenty years—only the fishery in this big ocean has not been going on so intensely as in the southern part. We have great swarms of fish, and they always give the same idea of being near the limit of dying a natural death. In this way we can also see that one fish is able to produce its kind perhaps twelve or fifteen times before it dies. These swarms give you an idea of a great stock of fish prospering and not being in any danger from man. If that is true — and it is impossible to explain or prove it in a few minutes — then it gives you great hope that you will be able, as an administrator or a scientific or a practical man, to inspire your people to go on developing the fisheries still more, and I think no practical purpose can be greater than that. In other parts of the sea, for instance, in the North sea, by means of your great fleets that sweep over the whole of the ground, if you study the question of the fish, you very seldom find old fish. I saw, for instance, last summer, in Finland, a great swarm come from here where nobody had ever fished before, and there were huge haddocks which never had been under the influence of fishing boats before. These fish were from eleven to twelve years old. If you take the age of the haddocks in the North sea, for instance, you very seldom find such old specimens. The great majority of them are only two, three, or four years old at the outside. Now, I am able to tell you that all these investigations give us a practical picture of the fish in all its uses. I say, we are

able by hard work to give a true picture of what the fish is to be, what the stock of the fish is with regard to the different classes, and we can tell you what the fish stock will be in all these respects in the year 1908. And if we go on for years and give the picture for each year, you are able to give a picture of how the influence of man will affect the fish; at the same time you can also give an idea of what you are able to predict for the future of the fishermen. You get a knowledge of the great fish problems of the future. Are we to inspire the people to go on, or are we to induce them to exercise economy? And this, in my opinion, is the great basis for international co-operation.

The PRESIDENT: There is one country which I entirely forgot to mention, that is Great Britain. We have a representative here, Prof. D'Arcy Thompson; he can tell us, I am sure, something interesting.

Prof. D'ARCY THOMPSON: It is clear, from the debate to-night, that our work ranges over many sciences, and we are reminded thereby that the points where science is most interesting, where advances are most easy, where the promise of advance is greatest, are those points where one science meets another. We have heard from the several speakers how the science of statistics, the physical sciences, the biological sciences, and your own science of geography, all have their place in our programme of work, and it is where one interprets and illuminates another that new ideas emerge and new discoveries are made. Prof. Otto Pettersson, more, perhaps, than any other individual man, has shown us the way, telling us that we biologists were not doing enough as biologists, but must have the help of the physicists and must obtain an insight into physical problems before the methods of our own work could be deemed adequate and sound. It was Prof. Otto Pettersson who guided us more than any other man, by precept and example, towards this important international co-operation whose progress has been reported to you to-night, and of the results of which we hope to have still more satisfactory evidence in a little while to come.

The PRESIDENT: I think all that remains for us is to wish hearty success to the work of the International Council, presided over by Dr. Pettersson.

Prof. OTTO PETTERSSON: I think I will just say a few words on behalf of my fellow-colleagues of the International Investigation. I think the last word to be spoken to-night should be a word of thanks to the President of this illustrious Society and to the members for the hospitality they have shown to us, and for the manner in which they have had the kindness to describe our work.

GEOGRAPHY AND COMMERCE.*

By GEORGE G. CHISHOLM, M.A., B.Sc.

THE subject which I have chosen for this address is one that is very apt to raise questions that might lead to keen and even warm controversy. For the raising of such questions no occasion could be less suitable, and it will therefore be my endeavour to handle the subject in such a manner that burning questions may be altogether avoided. For that reason I propose to consider the relations of geography and commerce from an historical point of view, which at least gives one the opportunity of confining one's self to less debatable ground than is entered on when one ventures on prophecy, that "most gratuitous form of error," as it is

* Presidential Address to the Geographical Section, British Association, Leicester August 1, 1907.

styled by George Eliot. That I shall be able to keep wholly free from debatable matter is more than I can hope, but it is my intention to try to avoid it as much as possible by illustrating my subject chiefly by reference to the broad, familiar facts of commerce considered in the light of geographical and other implications that may be described as obvious—obvious, and yet perhaps not unimportant and not unworthy of having attention specially called to them; for, after all, the obvious is obvious only to those who are looking in the right direction and with the proper focus, not to those who are looking another way or far beyond what is immediately before them.

As the first of these obvious considerations, I may point out that unquestionably the foundation of commerce is the mutual advantage to be derived from the exchange of commodities produced in different places. Geographical relations are therefore of necessity implied in commerce. But those who carry on commerce have always aimed at the greatest possible advantage to themselves, and the commerce that has always attracted the greatest attention is that which has resulted in the greatest additions to their wealth. Peculiar importance therefore belongs to the geographical relations between regions which under any given circumstances lead to the most profitable exchanges.

But before applying this consideration there is another point which must detain us a little. In speaking of wealth, as I have just done, I am aware that I have made use of a term which economists recognize as one requiring a great deal of exposition to prevent misunderstanding, and there is not the slightest doubt that in the history of commerce it has led to great misunderstanding, and therefore it is necessary, without entering upon an economic disquisition on the subject, to consider the meaning of the term "wealth" sufficiently to indicate the way in which that misunderstanding has arisen. For this purpose it will be most convenient not to give one of the highly abstract definitions of wealth which a modern political economist will give us, but to go back to the more concrete considerations set forth by Adam Smith, who tells us that "the wealth of a country consists, not in its gold and silver only, but in its lands, houses, and consumable goods of all different kinds."* Now, no definition of wealth is given by economists which excludes this last form of wealth, but the misunderstanding to which I refer arises from the fact that this form of wealth is apt to be overlooked. It may happen that a country or region produces a great abundance of consumable goods in proportion to its population, and hence from this point of view be entitled to be regarded as wealthy, and yet may not be a country or region that attracts much attention by its wealth. What has always attracted attention to wealth, and what has caused wealth to have an important effect in directing the main streams of commerce, and commerce to have an important effect, direct or indirect, on history, has been the accumulation of much wealth in few hands, so that a comparatively small number of people in a community have enjoyed, directly or indirectly, the command of a great deal of labour, have had the means of providing themselves with commodious and luxurious houses, with a variety of other comforts, luxuries, and splendours, and over and above that the means of so directing labour as to add still further to their wealth. Such conditions may exist where the great bulk of the population are extremely poor.

Now, it happens that wherever a great abundance of consumable commodities is produced on a relatively small area there is always in that area a greater or smaller number of individuals in whose hands much wealth is concentrated. It is for economists to explain how this comes about, or has come about, but it is

* 'Wealth of Nations,' book iv. ch. i.

a fact of the utmost importance for geographers to bear in mind in considering the relations of commerce and geography.

The existence of a relatively dense population may be due to different causes, such as a great abundance of agricultural products, the carrying on of mining or manufacturing industries, the concentration of the administration of a great dominion, or the pursuit of commerce itself. Where it is due to any cause but the production of great quantities of the necessaries of life foodstuffs must be imported in large quantities, and where the pursuit of manufactures is the cause, or one of the chief causes, then the importing of raw materials is entailed. Where these are most advantageously found there also much wealth is likely to be accumulated in few hands.

Further, it is to be noted that where a comparatively small number have the command of much wealth there is sure to be a demand for things of such value that they can be bought only by the wealthy, things that are more or less rare, such as precious metals, jewels, gems, ivory, fine woods, ornamental skins and feathers, manufactured goods of rare materials or of fine quality, as well as, in many places and in most periods of history, slaves. Such trade is necessarily limited in amount, but puts great profits in the hands of those who carry it on with success, and for that reason attracts attention.

With this class of goods may be associated certain others that may be regarded as intermediate in position between those which are bought only by the wealthy and those which are not merely generally consumed but also very widely produced. Amongst these may be mentioned salt, the consumption of which is universal, but the production of which, away from the seaboards of the warmer latitudes, though in a sense widespread, is strictly confined to scattered spots. A more interesting example is that of spices, one of which, pepper, has from a remote period been very generally consumed, but in still smaller quantity than salt, and for that reason has been able to bear still higher transport costs. For ages these costs were very high, for various reasons, amongst which were risks both numerous and great, but the profits of those who were successful in the trade were proportionately high.

Peculiar importance in commercial geography is thereby given to the relations between the regions that yield or yielded spices and those in which they were consumed at a great distance from the place of origin, and one of the most important facts in human history is that for many hundreds of years an extremely valuable trade in these commodities was carried on between India and the Mediterranean. Spices no doubt were less talked about, less prominent as symbols of wealth, than gems and jewels, fine woods and ivory, but they formed the basis of a larger trade, which was in the aggregate probably more profitable than that in the still more costly wares.

The geographical relations between India and the Mediterranean necessarily determined the routes followed by this traffic. These routes were singularly few. They were practically confined for the most part to minor variations in two main routes, one by way of the Red sea, the other by the Persian gulf. At more than one period of history, in very early times in the days of the splendour of Assyria and Babylonia, and again in the flourishing days of the Caliphs of Baghdad, the Persian gulf route had a peculiar advantage in the existence of the large and rich populations that afforded an intermediate market; and another important fact in the relations of geography and commerce, one that has had vast effects on human history, is that the physical conditions of the area between the head of the Persian gulf and the Mediterranean are, and throughout human history have been, such as to make the most convenient outlet of that route some point or points on that seaboard which in ancient times was known as Phœnicia. Between that seaboard and

the Euphrates the desert is sufficiently narrowed to be most easily crossed. The most favoured outlets on this seaboard were not always the same. They varied in different circumstances, which gave a different geographical value now to one point, now to another. But on these variations, interesting and instructive as they are from a geographical point of view, there is no time to enter on this occasion, and it will be enough to call attention to a very interesting paper by the late Elisée Reclus, entitled "La Phénicie et les Phéniciens," dealing with this and other matters connected with the geographical basis of Phœnician commerce and industry—a paper, too, that is apt to be overlooked, inasmuch as it was contributed by him, with a generosity characteristic of one of the least self-seeking natures with which the world was ever blessed, to a rather out-of-the-way publication, the *Bull. de la Soc. Neuchâteloise de Géog.* (vol. 12, 1900). But while I do not desire to enter into details regarding the Phœnicians, it is necessary to point out how naturally, and indeed inevitably, this position of the Phœnician cities between the Mediterranean on the one hand and Mesopotamia and the Persian gulf route to India on the other hand brought other sources of wealth in its train. Conveniences for the distribution of manufactured goods have always been one of the most important advantages for the development of manufacturing industry, and the wealthier the community forming the market for the products of such industry the more valuable are the manufactures likely to be. Hence the Phœnician manufactures of fine linens and woollens richly dyed, glass and metal wares, for which other parts of the Mediterranean and its seaboard furnished the raw materials, slaves to do the manual labour, and food for that population which the narrow strip of Phœnicia could not adequately supply. Food is indeed a bulky commodity, but even bulky commodities could be transported by sea at a relatively small cost, and in connection with this traffic we must note the indirect effect which the wealth of Phœnicia must have had in promoting the settlement of districts favourably situated for supplying food, and especially of such districts where the opportunities for producing food were great, but not fully turned to account, where the supply therefore could easily be made superabundant in proportion to the wants of the population. This shows that, from the very nature of commerce, its benefits are not confined to one side. Although the geographical conditions for a long period of time led to a special accumulation of the wealth due to commerce on Phœnicia, Phœnician trade promoted the growth of wealth and civilization elsewhere. The Greeks of the Ægean distinctly recognized what they owed to the Phœnicians, and they in their turn derived much wealth from Eastern trade, even though not so directly as the Phœnicians, and they in their turn derived some of the food for a commercial population from the far West—from Syracuse, Sybaris, and even the distant Kume. But the far East had a peculiar fascination. As the articles from which much of the wealth of commerce was derived originally came from India, it was natural that the idea should arise that India was a wealthy country, a country well worth possessing. I am not aware whether India ever was in historical times a wealthy country in the sense of producing a great abundance of the necessaries and ordinary conveniences and comforts of life in proportion to the population, but if it was not rich itself it was at least the means of making others rich. There can hardly be a doubt that the desire of possessing this country of real or imagined wealth was prominent among the motives that led Alexander the Great to embark on that enterprise which had such surprisingly—one might almost say miraculously—widespread, profound, and lasting effects on the history of the near East. If we may accept as historical the speech in which Quintus Curtius represents Alexander as having addressed his troops after his victory over Porus, in order to encourage them to advance further into India, that speech affords fairly strong evidence of what has just been stated. "What now

remained for them," said Alexander, "was a noble spoil. The much-rumoured riches of the East abounded in those very regions to which their steps were now bent. The spoils accordingly which they had taken from the Persians had now become cheap and common. They were going to fill with pearls, precious stones, gold, and ivory, not only their private abodes, but all Macedonia and Greece." * Alexander was no merchant. Pepper was beneath his notice. His symbols of wealth are those which have always most powerfully affected the imagination. Later on, however, we shall meet with a king who was a merchant, and who understood perhaps better than Alexander wherein consisted the value of Indian trade.

At the outset of his career Alexander had destroyed Tyre, thinking, no doubt, that he had thereby wiped away the claims of one rival for a share of the wealth of the East; but it is a noteworthy fact that he did not thereby destroy the value of the site of Tyre under the conditions which then subsisted. Tyre revived, and again obtained wealth from its trade with the East, as it did again and again in subsequent history. A heavier blow to Tyre than its mere destruction was the ultimate accomplishment of Alexander's idea for founding a great seat of commerce on the harbour which he saw could be created in the neighbourhood of the Nile delta. The foundation of Alexandria and the successful efforts of the successors of Alexander in Egypt to divert a large part of the trade in spices and other Oriental goods to the Red sea route for the Mediterranean did more than a single act of war to deprive Tyre and other Phœnician cities of the peculiar pre-eminence which they had long enjoyed in the trade in those wealth-bringing commodities.

But perhaps the history of Venice shows even more clearly than that of Tyre the importance of this Eastern trade in connection with certain inevitable geographical relations. The foundation of the future commercial glory of Venice may be said to have been laid when Rome planted her colonies north of the Po. The gradual clearing of forests gained for agriculture to a greater and greater extent one of the most favoured agricultural areas in Europe. There resulted a superfluity of agricultural products, which begot a trade by sea. The great outlet of this plain in Roman times was Aquileia, which, in the beginning of the fifth century, when no one of discernment could imagine that there would ever be other than Roman times, was described by a Roman man of affairs and minor poet as one of the nine great cities of the world. But before that century was out Aquileia was destroyed, never to recover. The value of its site was replaced, and that in a strange way, which no man of discernment could ever have foreseen. The time that saw the destruction of Aquileia and the times that immediately followed were such as made safety a prime consideration, and especially for all who possessed or desired to possess wealth. Refugees from Aquileia, and afterwards from other Italian cities, thought at first of nothing but safety. Many of them found it on a few muddy and sandy islands near the muddy shores of the lagoon in which Venice now lies. But here they found the means of trade. The sea could be made to furnish both fish and salt, and the rivers that flowed into the lagoon enabled them to exchange these commodities for provisions of other kinds, which the adjoining land could supply. Gradually this commerce grew, until in the eighth century we find the Venetians trading with Syria and Africa, Constantinople, and the ports of the Black sea.

Throughout the period of growth the policy of this trading republic, both by land and sea, is very significant. Venice early realized the force of Bacon's maxim "that he that commands the sea is at great liberty, and may take as much and as little of war as he will." Power at sea was necessary to provide security for her

* J. W. M'Crindle, 'The Invasion of India by Alexander the Great' (1893), p. 215.

commerce. In early times she generally owned allegiance to the Eastern Roman Empire, a suzerainty which could do her little harm and could and did do her much good. To that allegiance she adhered until she was strong enough to turn against and reap advantage from the overthrow of her suzerain. At an earlier date, before the close of the tenth century, she had conquered Dalmatia, and thereby destroyed the hordes of pirates who had found refuge in the innumerable harbours of that coast and constantly harassed the commerce of the Adriatic. At every opportunity she secured establishments and acquired possessions in the Levant.

On the land side, however, dominion would have added more to her risks than her advantages, and that dominion was not sought. For more than eight hundred years after the first flight to the islands of the lagoon, more than six hundred after the election of the first Doge (697), Venice possessed no territory on the mainland beyond a mere narrow ribbon on the edge of the lagoon. The nature of the situation made her indispensable to the trade of the land immediately behind. An incident belonging to the close of the ninth century illustrates the force of this observation. A keen dispute had arisen between the Patriarch of Aquileia and the Patriarch of Grado. Venice supported the Patriarch of Grado, and war seemed to be threatened. But so necessary had the commerce of Venice become to the inhabitants of the territory acknowledging the authority of Aquileia, that in order to bring about the submission of the Patriarch of Aquileia it was enough to close or blockade the port of Pilo, on the mainland opposite the *lidi*. The subjects of Aquileia then forced the patriarch to sue for peace.* On another occasion, in a dispute with the Bishops of Belluno and Treviso, the matter was again partly settled through the efficacy of the measures taken by the Doge Orseolo II., with the consent of the people, to stop commerce with the territory of the bishops, by which the inhabitants found themselves without supplies of salt, and without the means of exchanging their leather and meat for Venetian wares or selling the abundant timber of their forests for the building of Venetian ships.† In holding the outlets for maritime commerce Venice felt herself to be in the possession of "the keys of trade," to use the expression employed by Sir William Petty in speaking of the analogous position of Holland in later times at the mouths of the Rhine, Meuse, and Scheldt.

But while possession on the mainland was not necessary to Venice, she always recognized and sought the advantage of good relations with the occupants of the plains behind her, whoever these occupants might be, and on every occasion endeavoured to turn to her own benefit the vicissitudes of those plains. In her early days she is found now in alliance with the Greeks, now with the Pope, now with the archbishops of Ravenna, and now with the Lombards, just as it happened to suit her interests, and in any case taking every opportunity of obtaining direct and indirect advantages from trade with the most profitable customers in the plains. When famine pursued the steps of the Lombard invaders of Italy in the sixth century, "the Venetians in their pacific retreat," says Mutinelli, ‡ "could send their ships to the ports of Apulia and elsewhere to obtain victuals and corn for the famished barbarians," and in consequence the Lombards took them under their protection and granted them security and favours throughout the Lombard kingdom. When Charlemagne, at the invitation of the Pope, invaded Italy to deliver the Church from its subjection to the Lombards, Venetian traders promptly

* Romanin, 'Storia documentata di Venezia,' vol. 1, pp. 197, 198.

† *Ibid.*, pp. 270, 271.

‡ 'Del Commercio dei Veneziani,' p. 12.

appeared in the camp of the Franks at Pavia and sold to the Frankish chiefs all the riches of the East—Tyrian purples, the plumage of gay birds, silks, and other ornaments, pranked in which the purchasers stalked about in their pride, feeling, no doubt, that now at last they had conquered a land whose wealth would reward all their labours and hardships.* Charlemagne, it is true, was inclined to look with little favour on the Venetians, whom he regarded as supporters of the Greeks, but an attack by his son Pepin in 809 on the islands of the lagoon only served to establish the strength and security of their position, at least on the inner islands of the lagoon. By closing the passages of the canals, removing the navigation beacons, and fortifying and barring the chief entrances to the land, they succeeded in holding out during a siege of six months, till the heats of summer began to decimate the troops of Pepin, who, on hearing also of the approach of a Greek fleet, came to terms with the Venetians on conditions similar to those which had been maintained with the Lombards. The Venetians agreed to a tribute, but solely for the narrow strip of territory held on the mainland and in return for commercial privileges in the Frankish dominion, not for any recognition of the existence of the State. The tribute was afterwards paid or withheld according to the power which the emperors showed of enforcing it; but one permanent result of this incident was that the Venetians, perceiving the smaller security belonging to the islands nearer the mainland, of their own choice made the Rialto the capital of their little State† (810).

As a last illustration of the nature of the relations of Venice to the North Italian plains, we may refer to some of the points mentioned in a celebrated and often-quoted address delivered to the principal senators of Venice by the Doge Mocenigo just before his death (1423), at the time at which Venetian trade was at the very height of its prosperity. At that time Venice was in possession of a considerable tract of adjacent territory on the mainland, and there was a party favourable to further action on the part of Venice against the growing power of Milan. The aged and sagacious Doge feared that this party was going to gain the upper hand and elect as his successor Francesco Foscari, who, he thought, would involve them in dangerous and disastrous as well as useless enterprises. The immediate occasion of the conflict of views in the Venetian Senate was a request of the Florentines for support against alleged designs of the Duke of Milan. Moncenigo, however, not only warned the senators in the most earnest and urgent language against Foscari personally, but also advised them against the particular enterprise, maintaining that it was of no consequence even if the Duke of Milan made himself master of Florence, since the artisans of Milan would continue to send their manufactures to Venice, and the Venetians would be enriched to the loss of the Florentines. He then went on to give particulars of the trade of Venice at that time, dwelling specially on the value of that with Lombardy. To Lombardy alone, it appears, Venice sold every year cloths to the value of 400,000 ducats, *tele* (? linens) to the value of 10,000 ducats, wools of France and Spain to the value of 240,000 ducats, cotton to the value of 250,000 ducats, wine to the value of 30,000 ducats, cloth of gold and silk to the value of 250,000 ducats, soap to the same value, spices and sugar to the value of 539,000 ducats, dye-woods to the value of 120,000 ducats, other articles 110,000 ducats: in all, goods to the value of more than 2,500,000 ducats, the profit amounting to quite half a million ducats. With the exaggeration that comes natural to a lover of his country, Mocenigo goes

* 'De rebus bellicis Caroli Magni,' L. iii., quoted by Romanin, as above, vol. 1, p. 130.

† Romanin, as above, vol. 1, pp. 144–149.

on to say rather grandiloquently that to the Venetians alone land and sea were equally open; to them only belonged the carriage of all riches; they were the providers of the entire world.

All this trade, as well as that of Genoa and other Italian ports which shared with others in the spice trade, must have had a remarkably fructifying effect in North Italy generally. Agriculture and manufactures would be alike promoted, and in consequence of that the growth of population; and when war, with its attendant scourges, led to a diminution both of industry and population, this commerce could not fail to assist in bringing about a speedy recovery. It has already been hinted that in manufactures both Milan and Florence took a prominent place in the time of Mocenigo. In truth, manufactures in both cities are of much older date, and it may be interesting to mention here that even in the thirteenth century English wool was a commodity sufficiently valuable to bear the cost of transport to Florence. A letter has come down to us,* dated London, January 6, 1284, from the representative of a Florentine house, giving particulars as to purchases that he had made—in many cases for several years in advance—of all or a portion of the wool of many English monasteries from Netley and Titchfield in Hants, and Robertsbridge, in Sussex, to Grimsby, in Lincolnshire, and Sawley, on the Ribble, in the county of York (one of these monasteries, you may be interested to learn, as near Leicester as Monks Kirby, about midway between Rugby and Nuneaton), and from the work in which this letter is published, we also get particulars † as to the cost of conveying wool from London by way of Libourne to the Mediterranean port of Aigues Mortes in the same or the following century. Florence, indeed, depended on England, Spain, and Portugal for wools of fine quality, its own and other wools of Italy being of very inferior value, so that when four bales of English wool were worth in Florence 240 gold florins, the same quantity of wool of Garfagna dell' Aquila was only worth 40 florins.‡ The author of this work adds that he has found no indication of the prices of the wools of Spain and Portugal in Florence. Besides manufacturing cloths from the raw material, Florence carried on a large trade in dressing and finishing woollens manufactured in Flanders and Brabant, and brought to Florence either by way of Paris and the Saône-Rhône valley or by way of Germany and across the Alps. In the time of Mocenigo many of these products of Florentine industry came to Venice for export. In the address already referred to, Florence is said to have sent to Venice every year 16,000 pieces of cloth, which were sold to Aquila, Sicily, Syria, Candia, the Morea, and Istria.

It will be noticed that in the address above quoted Mocenigo lays no special stress on the spice trade, but there is not the slightest doubt that spices were amongst the most important commodities with which the Venetians provided a large part of the western world. Just as nowadays the large trade of Britain in bulky goods

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* Published (1765) in a work having no author's name, but stated in the British Museum Catalogue to be by G. F. Pagnini della Ventura, and bearing the title 'Della Decima e delle altre Gravezze della Moneta, e della Mercatura de' Fiorentini fino al secolo XVI.,' the third volume of which contains "La Practica della Mercatura" of Balducci Pegolotti (ascribed to the first half of the fourteenth century), under whose name the work is entered in the British Museum Catalogue. The date of the letter is given on p. 94 of vol. 2, and the letter itself on pp. 324–327 of the same volume. For the identification of the names of monasteries in their much-disguised Italian forms and spelling, I am indebted to my friend Mr. A. B. Hinds, M.A., editor of the last-issued volume of the *Calendar of State Papers* (*Venice*). Most of them, however, are entered and identified in the list given from Pegolotti on pp. 629–641 of Cunningham's 'Growth of English Industry and Commerce, Early and Middle Ages,' 4th edit. (1905).

† *Ibid.*, vol. 3, pp. 261–263.

‡ *Ibid.*, vol. 2, p. 95.

makes of this country a great entrepôt for the more valuable and less bulky, so in Venetian times the exceptionally large population behind Venice receiving and supplying the bulky goods thus fed the shipping which brought to Venice a much larger proportion of the more valuable goods of the East than was brought to other ports. But there is plenty of direct evidence of the importance of Indian trade to Italy in the Middle Ages. It is to be remembered that of necessity this trade enriched other countries before it reached Venice, and in proof of its importance in the Mediterranean generally, one may call attention to the investigations of the Venetian Marin Sanuto Torcello about the end of the thirteenth century, who, we are told, saw with indignation that the defeats of the Christians in Palestine were specially due to the power of the Soldans of Egypt, and perceiving that their great power derived its nourishment from the commerce with the Indies, based on that observation the projects which he urged on Christendom for the overthrow of that power. It is further significant that a sea-way to India should have been sought by Genoese as early as 1291,* and even more significant that a century later Venice should have found it worth while to maintain a consul in Siam.†

But the clearest evidence of the supreme importance of the Indian trade to the Italian cities is to be found in the results of the discovery which finally diverted from Venice and the Mediterranean the great bulk of the Indian trade until that trade had lost all the special significance which it had retained for thousands of years. It need hardly be said that I refer to the discovery of the sea-way to India by the Portuguese in 1497–9. Of the feeling aroused in Venice by this discovery Romanin has reproduced,‡ from the 'Diarii' of Priuli, an interesting contemporary record, written with reference to a despatch to the Doge probably from Pietro Pasqualigo, a Venetian envoy at Lisbon at the time of the return of the second Portuguese voyage to India under Cabral. The letter is stated to have reached Venice on July 24, 1501. After giving the letter, in which we are told, among other things, how the Portuguese had charged their ships at Cochin with spices at a price which the writer feared to mention, Priuli adds: "On the arrival of this news at Venice all the city was deeply moved and remained stupefied, and the wisest held it for the worst news that could reach them. For, it being recognized that Venice had risen to so high a degree of renown and wealth solely by the commerce of the sea and by navigation, by means of which every year a great quantity of spices was brought thither, which foreigners then flocked together to acquire, and that by their presence and the traffic they obtained immense advantages, now by this new voyage the spices would be brought from the Indies to Lisbon, where Hungarians, Germans, Flemings, and French § would seek to acquire them, being able to get them there cheaply; and that because the spices that came to Venice passed through the whole of Syria and the countries of the Soldan, paying in every place exorbitant duties, so that at their arrival at Venice they were so weighted that what at first was of the value of a single ducat was raised in the end to sixty and even a hundred ducats; from which vexations, the voyage by sea being exempt, it resulted that Portugal could give them at a much lower price." So said the wisest, but it is interesting also to note what was said by the less wise. Priuli goes on: "And while the wisest saw that, others refused to believe the story [these,

* See the account of this attempt and its results, so far as they are known, in G. H. Pertz, 'Der älteste Versuch zur Entdeckung des Seeweges nach Ostindien.' Berlin, 1859.

† Romanin, as above, vol. 3, pp. 335, note (5).

‡ As above, vol. 4, p. 461.

§ We must recognize with due humility that the English are of little account in Venetian eyes in 1501.

I presume, were the least wise], and others again said that the King of Portugal would not be able to continue this navigation to Calicut, since of thirteen caravels only six had returned safe, the loss would be greater than the advantage, and that it would not be so easy to find men who would consent to risk their lives in so long and perilous a navigation; that the Sultan of Alexandria, seeing the loss of so fine a profit as that obtained by the passage of the spices through his lands, would see to that."

But in this case it happened that the wisest were right. The effects of this discovery were not long in making themselves felt in the notable diminution in the sales of spices at Venice. Under the date February, 1504, Priuli enters in his diary, "The galleys of Alexandria have entered into harbour empty: a thing never before seen." In the following month the same thing happened in the case of the galleys from Beirut.* Under August, 1506, it is stated that the Germans at the fair of the preceding month had bought very little. Various remedies for these evils were thought of, and among these it is interesting to note that in 1504 the Council of Ten seriously discussed a proposal to empower an envoy to the Sultan of Egypt to come to an agreement with him, if possible, for the cutting of a canal through the Isthmus of Suez.† But the proposal was not adopted. Other efforts to avert the results of the great achievement of the Portuguese were vain. Other disasters befel the republic about the same time. Not only was commerce taking another direction, but, says Romanin, "the wars of Italy were emptying the treasury, the Turkish power was despoiling the republic step by step of its possessions beyond the sea, and Venice was beginning to descend that incline which was to reduce it to a subordinate position among the powers of Europe."‡ North Italy generally suffered at the same time. The withdrawal of the greater part of the spice trade, by diminishing the growth of wealth among the inhabitants, made that part of the world a less important market for manufactured goods. Countries outside of Italy, where rival manufactures had already started, were increasing their wealth more rapidly, and thus imparting an increasing stimulus to their manufactures, and these increased while those of Italy declined. In 1338 the number of woollen factories in Florence is given at 200, making in all 70,000 to 80,000 pieces of cloth in the year; in 1472 the number of shops or factories had risen to 270, but no estimate is given of the quantity of the product; in 1529, however, the number of shops is said to have sunk to 150, and the quantity of cloth manufactured to 23,000 pieces per annum, and in the time of the editor of Balducci Pegolotti the quantity was only about 3000 pieces annually.§

Before going further, however, there is one point in the comments on the discovery of the sea-way to India quoted above from the 'Diarii' of Priuli which calls for notice. Hungarians, Germans, Flemings, and French, he observes, will in future go to Lisbon to get the spices of India more cheaply than at Venice. This remark illustrates the difficulty of shifting the geographical point of view according to circumstances, a difficulty of which at all times abundant illustrations can be offered. The purchasers of spices who came first into the mind of Priuli are Hungarians and Germans. It was inevitable that they should be among the leading customers of Venice. The Hungarians were supplied from the Dalmatian ports which belonged to Venice. The Germans came by way of the Rhine and the Elbe, and then across the Alps to get supplies for central, north-western, and northern

* G. Coen, 'Le Grandi Strade del Commercio Internazionale proposte fino dal Sec. XVI.' (Leghorn, 1888), p. 71.

† Coen, as above, pp. 82, 83.

‡ As above, vol. 4, p. 466.

§ 'Della Decima,' as above, vol. 2, pp. 64, 105.

Europe. But it was neither Hungarians nor Germans who came in greatest numbers to Lisbon to buy the spices which Portuguese ships brought from the East. In any case Lisbon had no advantages like those of Venice for supplying by land a large and rich population immediately behind it. The valley of the Tagus was small and poor, and had not the capacity for expansion in wealth and population which the Lombard plains had when the commerce of Venice began to grow. The bulk of the spices brought to Lisbon had therefore to reach their final markets by routes that did not pass through Lisbon into the interior. To supply the most important of those markets it was the Dutch, the people who held "the keys of trade" for the important valleys of the Rhine, Meuse, and Scheldt, who came to Lisbon in greatest numbers to buy spices of the Portuguese. And here it has to be added that, in spite of the discovery of the sea-way to India, the Venetians continued to retain great advantages in the spice trade with Hungary and parts of Germany, as well as, of course, the northern plains of Italy. Things did not remain always as bad as recorded in the years 1504 and 1506. The Portuguese, while maintaining successfully for a hundred years the monopoly of the trade in spices at the place of origin in the East, found their advantage in dividing the trade with Europe between the sea-way and the Persian gulf route, of which latter route they held the key since the final capture of Ormuz in 1515. The trade by way of the Tigris through Baghdad (the so-called Babylon of those days) and the Euphrates to the old Phœnician seaboard was again revived, and was maintained as long as Portugal held command of the trade. It was by this route that the first English commercial expedition to India, that of Newberie, Leedes, Story, and Fitch, went out in 1583, and by which Ralph Fitch, the sole survivor of that expedition, returned in 1591. By this route Venice got back some of her spice trade; not perhaps with the same profit to herself as formerly, but still a trade of no slight importance, not only to Venice, but also to Augsburg, Nuremberg, and some of the other cities of South Germany.

But beyond doubt the bulk of the trade was now carried on by the sea route, and we are thereby enabled to get a better idea both of the amount and the nature of the trade. On both points we get information from the 'Narrative' of the above-named Ralph Fitch, who tells us that "the Fleete which commeth every yeere from Portugal, which be foure, five, or sixe great shippes, commeth first hither [to Goa]. And they come for the most part in September, and remaine there forty or fiftie dayes; and then go to Cochin, where they lade their Pepper for Portugall."* Now, in 1583 a ship of 500 tons would certainly be called a great ship. In 1572 the largest vessel sailing from the port of London was of 240 tons,† and the largest of the first fleet of the East India Company was one of 600 tons. I could give more definite information as to the capacity of these fleets at that time if I knew exactly what a *salma* was, for in a report on Portuguese trade sent to the Grand Duke Ferdinand I. of Tuscany (1587–1608) we are told that the fleet consisted of four or five carracks of the capacity of 5000 or 6000 *salme*.‡ But a *salma* is a term for which one sometimes gets a very indefinite meaning, at other times definite but very diverse meanings, sometimes a weight of 25 lbs. which is obviously too little, and again a weight of 1000 lbs., which is probably too much. The large dictionary of Tommaseo gives this latter weight with an example stating the capacity of a ship; but if that were the meaning then the carracks would be of a burden of from 2250 to 2700 tons, a much heavier tonnage than is elsewhere indicated, so far as I am aware, for

* Horton Ryley, 'Ralph Fitch,' p. 61. † *Ibid.*, p. 17.

‡ Angelo de Gubernatis, 'Memoria intorno ai viaggiatori Italiani nelle Indie Orientali dal secolo XIII. a tutto il XVI.,' p. 149.

vessels of the period. Probably 3000 tons would be the outside limit of the aggregate cargoes annually brought to Portugal, for in any case much room in the ships was required for the large crews of those days with their armaments, for then the idea of carrying on commerce by sea without being in a position to defend your ship was out of the question.

Of the commodities sent home from India, Fitch mentions in this place only pepper, and the correspondence of Albuquerque with the King of Portugal soon after the discovery of the sea-way to India clearly reveals how all-important the pepper trade was; but it may be worth while to give the complete list of the commodities which Ralph Fitch enumerates at the end of his 'Narrative' as coming from India and the country further eastward. The list is not a long one. It comprises pepper, ginger, cloves, nutmegs, and maces, camphora ("a precious thing among the Indians . . . solde dearer then golde"), lignum aloes, long pepper, muske, amber, rubies, saphires, and spinels, diamants, pearles, spodium, and many other kindes of drugs from Cambaia—all of them, it will be observed, having the character of being of high value in proportion to their bulk, so that a very great value of such goods might be carried in ships of small capacity.

Fitch does not tell us what was sent in return, but information as to that is to be had from other sources and presents one or two points of interest. In 1513 Albuquerque, after a long course of fighting, concluded a peace with the Zamorin of Calicut, in which it was agreed, among other things, that the Zamorin should supply the Portuguese with all the "spices and drugs" his land produced, and that "coral, silk stuffs, quicksilver, vermilion, copper, lead, saffron, alum, and all other merchandise from Portugal," should be sold at Calicut as heretofore.* Coral comes first in this enumeration. To us at the present day this does not seem a very important article of commerce, but it was otherwise then. One Mafio di Priuli, writing from India in 1537 to the Magnifico M. Constantino di Priuli, says, "At a great fair which is called that of Tremel I have seen buttons of coral sold for their weight in silver."† That is the point of view of a European in India, but a native of the East Indies in Europe at the same date would no doubt have spoken with astonishment of the amount of silver that could be got in Europe for a few grains of pepper. Our letter-writer says in his cheerful, hopeful, gossiping way, "The gains of these parts are other than those of Damascus, Aleppo, and Alexandria: for if one does not gain cent. per cent. from Portugal here, and from here back again, one thinks that one gains nothing. And three or fours years would be quite enough."‡ But, while he indicates how these immense gains are made, he also indicates clearly enough how they continue to be made—that is, how they are so counterbalanced by losses that if these great gains were not made on occasion commerce would cease. It was all very well to exchange your coral for spices, but the great matter was to get your coral out and your spices home in safety. The writer of this letter had entrusted to a friend who had left on a ship for Ormuz jewels of the value of 4000 Venetian ducats, but the jewels were lost. He believed that his friend was murdered. "But such losses," he adds, "will occur." Another time he lost more than 6000 ducats gold in Portuguese vessels going to Ormuz, and on another occasion he suffered great loss when Pegu was sacked by the King of Burma.

These notes may serve to illustrate the conditions of trade in the glorious days for Portugal when fine fortunes were heaped up in Lisbon through trade, but the

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* Danvers, 'The Portuguese in India,' vol. 1, p. 283.

† P. 34 of the letter referred to as published at Venice in 1824.

‡ *Ibid.* p. 29.

great bulk of humanity got very little at least directly through that trade; but we have not exhausted the interest connected with the nature of the outgoing commodities for India, and to that it will be well to return. Another of the stipulations of the treaty of 1513 above referred to was, that while duties were to be paid in coin "the Portuguese were to pay for all the pepper and other merchandise they might purchase in kind," and, as the peace led among other things to a dearth of prizes, Albuquerque "was constrained to send an urgent request home for large quantities of merchandise to be sent out to make up for this deficiency."* How long this stipulation remained in force I cannot say, but things were certainly different a hundred years later. In the report to the Grand Duke of Florence above cited we are told that what the Portuguese carry to India for exchange is above all "silver in reals, and besides silver wine, oil, and some other sort of merchandise, such as coral, glass, and the like, of little importance;" and as to the silver, he adds that "the reals bring a gain of more than 50 per cent. as soon as they have reached India, for the real of eight, which in Lisbon is worth 320 reis, in India is sold and spent at the rate of 480 to 484 reis of that money, and with it one buys all sorts of spices and drugs which are sold there, except pepper, which is the monopoly of the King of Portugal and those to whom he gives a lease of that trade." The importance of silver among the outgoing commodities for India has continued from that time down to the present day, latterly, however, in diminishing proportion. For a long time after the date at which we have now arrived it was as predominant as a means of exchange with India as it was in the first century of the Christian era, when the drain of silver from the Roman Empire to the East was bewailed by the writers of that time. In the voyages of the English East India Company of the four years 1620–23 inclusive, the value of the bullion (chiefly silver) sent out to India was £205,710, as against only £58,806 worth of merchandise.†

Now, what is the meaning of the change in the position of silver in Indian trade which seems to have taken place between 1513 and the end of the sixteenth century? No doubt we may see there the result of another change in geographical relations brought about by a discovery nearly contemporaneous with that of the sea-way to India—namely, that of the New World. The first result of that discovery of importance to commerce was the pouring into Europe of large quantities of the precious metals, and the quantity was enormously enhanced after the silver-mines of Potosi, in Upper Peru (as it was then called), were discovered in 1545. It was probably this discovery that brought it about that of all commodities of such small bulk in proportion to their value as to stand the costs of transport to the East this was the one which could be sent out for most part with the greatest advantage. And this discovery no doubt also helps to explain why that of the sea-way to India had so little effect for a very long time in lowering the prices of spices in Europe, why prices even rose. At the time of the return of Vasco da Gama from the first voyage to India the price of pepper at Lisbon is estimated by Danvers‡ to have been about 1*s.* 5*d.* per pound, and we all know that the immediate occasion of the foundation of the English East India Company about a hundred years later was that the Dutch suddenly raised the price of pepper against the English from 3*s.* to 6*s.* and 8*s.* per pound.

But the particular commodity which made up the principal portion of the outward trade to India is, after all, a matter of detail, though not unimportant

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* Danvers, vol. 1, pp. 284, 286.

† I take these figures from p. 6 of the appendix to P. Colquhoun's 'Treatise on the Wealth, Power, and Resources of the British Empire,' 2nd edit. London, 1815.

‡ As above, vol. 1, p. 64.

detail. The main point on which I want to insist is that, whatever the commodities were, whether carried out or home, the nature of the trade with the East was little if at all altered by the discovery of the direct route to India by sea. The trade still continued to be one concerned in a moderate number of articles of small bulk but high value. It was merely a change of route that the Portuguese effected, and for more than a hundred years they remained in sole command of this route. After that, however, they were ousted from the greater part of this trade, and that the more valuable part, chiefly by the Dutch, and from a geographical point of view it is very interesting to note how the Dutch did it. They did not trouble themselves much about India proper. They left the Portuguese alone at Goa, and from that port as a base allowed them to pick up as much trade as they could at Calicut and Cochin, which, said Albuquerque, "were capable of supplying the Portuguese fleets until the day of judgment." But Malacca, on the straits of that name, gave command of the route to the further East, whence came in the end even larger quantities of pepper than could be got from India; whence came too ginger, cloves, and nutmegs, as well as the products of China. The importance of this place Albuquerque had accordingly recognized, and in 1511, the year after he took Goa, he took it also by the right that always belongs to the lion as against the jackal. This place was taken by the Dutch (1641), who had previously established themselves on Java and the Spice islands, where they maintained an absolute monopoly. Ceylon, again, was (and is) almost the only place from which the true cinnamon was to be obtained, so the Dutch took that island also from the Portuguese (1656). As long as the Portuguese were the sole Europeans in the East, Calicut and Cochin not merely furnished the Portuguese with Indian wares, but were important entrepôts for the spices, perfumes, drugs, and jewels of the Further East as well as of Chinese silks and porcelains; but the trade in these commodities could be wholly or largely diverted to places in the possession of the Dutch. Even before the capture of Malacca and Ceylon a Portuguese viceroy had reported (1638) that the Dutch had a monopoly of trade from the Bay of Cochin China to the point of Sunda.

But this change also was little more than a change of route. The general character of the Eastern trade remained the same. The English East India Company, whose operations, through the hostility of the Dutch, came to be restricted to India proper, there founded a trade that gave much more opportunity for expansion under modern conditions than that of the Dutch, but for a long time it retained the same character. All the commodities enumerated by Colquhoun as brought back by the voyages of 1620–3 in exchange for the bullion and merchandise sent out were pepper, cloves, mace, nutmegs, Chinese and Persian raw silk, besides calicoes, the sole manufactured article, and one of course that had relatively a much higher value than now, when the direction of the trade in that commodity is reversed.

A similar character for a long time belonged to the trans-Atlantic trade, even though the costs of transport in that case were less, and favoured the development of a trade in somewhat bulkier commodities. Furs from the Far North, tobacco from Virginia, sugar and afterwards coffee and cotton from the West Indies, were by far the most prominent imports. It was the tobacco trade of Virginia that first enabled Glasgow, which at the time of the union of the English and Scottish Parliaments was an insignificant town with less than 13,000 inhabitants, to convert itself into a seaport, and thus lay the foundations of its subsequent prosperity. Now tobacco makes up less than 1 per cent. of the value of the goods imported at Glasgow, and though that may be partly due to a diminution in the actual quantity of tobacco imported at Glasgow, this result has chiefly been brought about by changes in relative values. A hundred years ago the value of the imports into Great Britain

and Ireland from the British West Indies was about one-fourth of the total value of the imports from all parts; now it is less than 1 per cent. of that value.

What has brought about such changes, what makes the essential difference between recent and all previous commerce, is the series of enormous improvements in the means of communication which followed so closely on the invention of textile machinery, and the improvement of the steam-engine in this country. These improvements have had two important effects on commerce. First, they have facilitated the maintenance of order and security both by land and sea, and thus enormously reduced the risks of commerce. Secondly, they have directly lowered the cost of transport for different goods in different degrees. Bulky goods of little value could now for the first time be profitably conveyed many hundreds of miles by land to a seaport, and there load ever larger ships for distant shores, thus opening up markets with vast undeveloped resources in the heart of great continents. Along with these bulkier goods the more valuable goods are carried at a cost far below that of former times, so that for such commodities as pepper the mere freight is almost a negligible item.

At the present day there can be no doubt that in point of quantity the spice trade is much larger than it ever was. If Venice could get the whole of that trade into her hands, a thing which she never had, notwithstanding the patriotic boast of Doge Mocenigo, the trade would not now bring her a tithe of the wealth which it brought in the days of her grandeur. Much has been said of the sudden "fall" of the Portuguese and Dutch in turn, and that fall has often been explained by mistakes in method. "The fall of the Dutch colonial empire resulted," says Sir William Hunter, "from its short-sighted commercial policy. It was deliberately based upon a monopoly of the trade in spices, and remained from first to last destitute of sound economical principles."* But one may well ask, Did the Dutch ever fail in a manner for which they were in any way responsible? It is true that the Dutch East India Company did not supply as many people as they could with the spices of which they held the monopoly. But that was not their aim. It is true that they did not build up a great empire like that of the English East India Company. But neither was that their aim. Their aim was to declare dividends, and dividends they declared. The profits of the company down to 1720 averaged 20 per cent. per annum, never sinking below 15 per cent., and sometimes rising to 50 per cent. If spices ceased to enable them to declare such dividends, that was not their fault. It was James Watt, George Stephenson, William Symington, and Robert Foulton, who, without intending it, and without being able to foresee what in this respect they were destined to do, sucked the value out of pepper, and that in a manner which neither the strength of armies nor the subtlety of statesmen could have done anything to prevent.

Now the countries that offer the most attractive markets for the greatest quantities of goods of all kinds are no longer those which look to the spice trade or to trade in any specially valuable commodities for their enrichment, but those which abound in coal, so placed as to develop a great amount of manufacturing industry, an industry engaged for the most part in working for the million, not merely in producing the luxuries of the rich. The commodities of very small bulk in proportion to their value now have a comparatively insignificant place in commerce. The precious metals and precious stones still, indeed, retain a good deal of their former importance. But very few vegetable or animal products can be put in the same category. Rubber, indeed, may be reckoned as one, and very handsome

* *Imperial Gazetteer of India*, 2nd edit., vol. 6, p. 362.

profits are reaped from some rubber estates. But every one knows that such exceptional profits can be reaped only for a short time. Of animal products, ornamental feathers are the most valuable in proportion to their bulk. Egrets' feathers, I believe, are seldom worth less, and often worth a good deal more, than twice their weight in gold, but ornamental feathers altogether make up less than a third of 1 per cent. of the total value of British imports.

Perhaps the greatest feature of modern commerce is the unparalleled manner in which it has promoted the increase of population nearly all the world over. Rendering it possible for manufacturing and commercial peoples to depend in a very large measure for their very means of subsistence on supplies brought from the ends of the Earth, it is rapidly pushing the settlement of vacant land to the base of the mountains and the edge of the desert. Fifteen years ago Professor Bryce said, "We may conjecture that within the lifetime of persons now living the outflow from Europe to North America will have practically stopped."* We are at least nearing the time when the "new lands" of this Earth in the temperate zone will all have been allotted. The results of such a check to expansion after a long period of stimulation to expansion must be momentous, but what the nature of these results will be I for one confess that I am unable to foresee. I am, however, convinced that, if we are to be enabled to make any probable forecast as to the course of future development, one of the most important aids to that result must consist in the study of the relations of geography and history from the point of view which I have endeavoured to indicate. To study these relations merely with reference to the immediate causes and effects of wars and treaties gives little real insight into the working of geographical influences in history. As in the study of the human body medical men have recognized the necessity of ascertaining with the aid of the microscope the normal functions of the cells of which the body is composed, the pathological states that interfere with their normal working, and the effects on one part of the body of minute disturbances of function in another part, so in tracing the course of history it is becoming more and more recognized that the minute gradual silent changes must be inquired into and taken into account, not merely in relation to the regions in which they take place, but in relation, it may be, to regions far distant. Such studies, it is true, are not confined to the geographer. In them, indeed, the geographer must seek the aid of workers in other fields; but there can hardly be a doubt that it must help greatly towards arriving at a sound solution of the problems presented to keep steadily before one the geographical point of view. The field for such studies is, of course, immense, the material perhaps not all that could be wished; but I can imagine no task more delightful for those who have the opportunity to engage in it than that of seeking out and examining from that point of view such material as actually exists.

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* "The Migration of the Races of Men considered Historically," in the *Scottish Geographical Magazine*, 1892, p. 419.

REVIEWS.

EUROPE.

Geography of Europe.

'Europa.' Zweite Auflage des von Dr. A. Philippson und Prof. Dr. Ludwig Neumann verfassten Werkes, neu bearbeitet von Prof. Dr. A. Philippson. Pp. xii., 751 (including 33 pp. of index). Leipzig and Vienna: Bibliographisches Institut. 1906.

'Grundzüge der Länderkunde.' By Dr. Alfred Hettner, Ordinary Professor of Geography at the University of Heidelberg. First volume, 'Europa.' Pp. xvi., 737 (including 41 pp. of index). Leipzig: 1907.

'L'Europe (moins la France) au début du XX^e^ Siècle. By M. Fallex and A. Mairey. Pp. 624 (no index). Paris: 1906.

This new edition of the volume on Europe belonging to the *Allgemeine Länderkunde*, edited by Dr. Wilhelm Sievers, is in a large measure entitled to be regarded as a new work. The text is increased from 618 to 710 pages, exclusive not only of the index, but also of 17 pages of bibliography, which forms a new feature in this edition. Moreover, the first edition had nine pages devoted to the Caucasus, which is now assigned to the volume on Asia, so that the additional matter in this edition extends to quite a hundred pages. The contents are also in a large measure rearranged, recast, and rewritten, and every page of the book bears witness to careful revision. Some of the rearrangement is altogether to the good. This may be said unhesitatingly of the general introductory section, which now extends to 137 pages instead of 22 pages, as in the previous edition—an extension, however, not wholly due to the introduction of new matter, but largely to the transference to this general introductory survey of the sections (all ably rehandled) on climate, vegetation, animal life, the inhabitants, and commercial intercourse, all rather awkwardly introduced in the previous edition in other parts of the volume. In the former edition, for example, the general considerations as to climate came after the treatment of the different sections into which Europe was divided from a physical point of view, in each of which there were brief isolated notes on climate; and the section on commercial intercourse came at the end of the whole book so far as it related to inhabited Europe. Now this introductory survey forms a methodically arranged and extremely interesting whole, leading up to the section on commercial intercourse as its culmination, for Dr. Philippson holds that commerce is the most important instrument which the people of Europe make use of in attaining the goal towards which, if we may judge from the course of recent history, they are powerfully steering, the Europeanization of the whole Earth (p. 113).

The rearrangements made in the rest of the volume are not so satisfactory. In this portion of the book one would like to have had either rather more or rather less rearranging of the contents. In the former edition, Europe is first treated from a physical point of view in different sections and subsections, and the countries of the continent are afterwards treated separately in regular order as political entities. In the present edition Dr. Philippson has proceeded otherwise. He has in a large measure adhered to the divisions and subdivisions of the previous edition. All Europe is first divided into three great divisions: first, the region of the South European Folded Mountains; second, the North-West European Schollenland; and third, the Russo-Scandinavian Tableland (*Tafel*). The first of these divisions is subdivided into six sections, entitled respectively, the Alpine Lands, the Carpathian Lands, the Balkan Peninsula, the Greek Peninsula and the associated islands (including some islands belonging politically to Asiatic Turkey), Italy, and the Pyrenean Peninsula. There

are similar subdivisions of the areas included under the two other great headings. But amidst this physical matter Dr. Philippson has intercalated, either in separate sections or otherwise, all that is usually included under the head of political geography, and the results are in many cases quite as awkward as was the arrangement of much of the general matter in the previous edition. In some cases the problem presented is simple enough. Thus, after the physical geography of France has been treated in various subsections under the general heading of *Das französische Schollenland*, a separate subsection is devoted to the French Republic. But from the table of contents we cannot learn that Belgium, the Netherlands, Turkey, Servia, and other countries are treated of as countries at all. Belgium, for example, is found under the general heading of the Middle German Mountain-sill in a subsection following two others dealing respectively with the Rhenish Slate Mountains in Belgium and the Belgium Middle and Low Lands, and Holland similarly in a subsection under the general heading of the North German Low Plain. The treatment of the minor German states is found scattered over the section bearing the heading of the German Schollenland, but at the end of that section subsections are added dealing with the kingdom of Prussia and the German Empire, the latter of which is also treated in the preliminary survey of the section, where we have a map of the empire. This preliminary treatment is referred to as a section on the *Weltlage* of the empire, but it is in reality a brief but illuminating sketch of the history of the German Empire (old and new). In the circumstances indicated, Austria-Hungary fares even worse than the German Empire. What is said about Vienna is introduced into a subsection headed the Alps East of the Brenner line. There follows another subsection entitled the Economic Condition (*Kultur*) and Population of the Eastern Alps, in which Vienna is only incidentally named. The kingdom of Hungary gets a subsection under the Carpathian Lands, but there is no general treatment of the Austro-Hungarian Monarchy and of Cisleithania till after the consideration of a portion of the German Schollenland 250 pages further on. The truth is that, while the general survey is an admirable exposition, the interest of which is maintained throughout by keeping the treatment in due subordination to the geographical idea, the treatment in the remainder of the work gives too much prominence to the geological idea. The interest is consequently divided, and though the individual sections are all handled in a masterly manner, showing fulness of knowledge, insight, and lucidity, yet they do not combine satisfactorily into a consecutive whole. Like the first edition, this volume is well furnished with maps (all carefully revised and where necessary redrawn) and other illustrations.

Hettner's 'Europa' is another excellent work. It inevitably challenges comparison with that of Dr. Philippson. In extent it is about one-seventh smaller, due allowance being made for differences in the size of page and in the type; for while Philippson's book is printed in the ordinary German letter, Hettner's is printed in what we call Roman characters, and the Germans call *antiqua*. Like Philippson's book, that of Hettner is well illustrated, both with coloured plates and with text cuts in black and white; but whereas in Philippson the majority of the illustrations are pictorial, in Hettner they are all maps or diagrams. It should be added that they are nearly all remarkably well chosen or constructed, the only fault to find being that some are on too small a scale to be sufficiently clear. As in Philippson, the general account of the continent, which, under the headings of Situation and Extent, Structure and Surface, Inland Waters, Seas, Climate, etc., extends to 106 pages, is throughout excellent, though exception may perhaps be taken to the placing of the section on Races and Peoples after that on Historical Development, the result of which is that on p. 51 we meet with the Indo-Germans, or Aryans, as a "primitive people" (*Urvolk*), although it is not till p. 60 that we get a definition

of a "people" (*Volk*) as distinguished from a race. But the chief distinction between the texts of the two works is to be found in the arrangement of the subdivisions. Dr. Hettner expounds the principles on which he has proceeded in this respect on pp. 105-106. He aims at something more scientific than the division according to states and provinces usual in text-books and school-books. He considers, however, that to make one's main divisions depend on the tectonic structure and morphology leads to results that are intolerable. Cornwall and Brittany belong structurally and morphologically to the same whole; so, too, do the Paris and London basins; and Schoonen, from this point of view, belongs, not to the Scandinavian peninsula, but to the Central European *Schollenland*. Divisions based on hydrography, climate, plant distribution, etc., are also rejected. The most convenient principle of division to adopt is, the author considers, the more or less complete separation of lands by the sea, or, failing that, by high mountains like the Alps and Pyrenees. Where the sea is the severing agent, we get land-units with special relations to the surrounding seas, and with a distinctive nature and population. Where mountains are the means of separation, the division is not so satisfactory. Districts which are in many respects one are thereby rent asunder; but this is an unavoidable evil, the degree of which can be mitigated by treating the mountains as a whole in connection with one or other of the land-areas thus separated. In any case, by following these general principles, we get something answering on the whole to the usual divisions of Europe. The British Isles, the Scandinavian peninsula, and Finland, together with the Kola peninsula, form a north-western zone. A middle zone is formed by other three sections, France, Central Europe (Germany with the adjoining countries, except Russia and Hungary), and Eastern Europe; and the Iberian, or, as Hettner calls it, the Spanish peninsula, Italy, Hungary with Transylvania, the Balkan peninsula, and Greece, form a south-eastern zone. The so-called zones, however, merely indicate the order of treatment. The special treatment is under the headings enumerated, under each of which there is first a general survey, to a large extent under the same headings as those used in the account of the continent as a whole, and this gives the opportunity of dealing with political units as such. Thus, in this general survey under Central Europe (*Mittel-Europa*), there is a section, headed "The States," divided into sub-sections on the Historical Development, Denmark, Belgium, the Netherlands and Luxemburg, the German Empire, Switzerland, the Austro-Hungarian Monarchy, and Russian Poland. After this general survey there is in each division a number of subdivisions, again largely based, as regards the great groups of natural districts (*Natürliche Landschaften*), on different relations to the sea—partly, also, in some cases, on separation by the sea; and it is only in these natural districts, the smallest divisions separately treated, that differences in inner structure and in phenomena dependent thereon—that is, tectonic and morphological differences—are taken primarily into account in forming the divisions. Whether in the larger divisions and subdivisions Dr. Hettner has always quite succeeded in carrying out his general principles may perhaps be doubtful, but the general result is on the whole satisfactory. Geology is throughout placed in due subordination to geography, and towards bringing about this result nothing seems to have contributed more than the final rule above mentioned—that of basing only the smaller units, which are made the subjects of detailed description, on tectonic and morphological considerations. There is no space to draw attention to any special features in Dr. Hettner's work, but it may be well to note a few errors for correction in the next edition. By some slip the date of the loss of the English North American colonies is given (p. 75) as 1789 instead of 1776, or at latest 1783 (the year of the peace). On p. 75 reference is made to Mongol invasions of Europe in the twelfth century, which is surely anticipating events. On p. 131 Ersk appears

for Esk; and on p. 125 there is the very natural and plausible error of "Carrantuo hills," an error which would have been avoided if Dr. Hettner had met with the name in writers who prefer the simpler spelling Carntual to the lengthier, more difficult, and more misleading Carrantuohill. Further, the map of the coalfields of Great Britain on p. 110 ought not to have been given without some further annotation. It is a reproduction on a small scale of that given in the fifth edition (1905) of Hull's 'Coalfields of Great Britain,' distinguishing the areas of visible coalfields, those in which coal is believed to exist at a depth of 1000–2000 feet, and the supposed coal areas at a depth of 2000 to 4000 feet, and has at least this merit—that, so far as it is accurately reproduced, it distinguishes those areas, small as the scale is, more clearly than in the original. But in Hull's book one has the text as a commentary on the map, and from this we learn how problematical some of those areas are. For example, a coalfield is shown running along the coast of Northumberland from the immediate vicinity of Berwick to a point south of Holy island. That is originally entered on the map on the basis of the report by Sir L. Wood, given in Part VI. of the Final Report of the recent Royal Commission on Coal Supplies; but Hull, who is generally sufficiently sanguine as to the extent of our coal supplies, expressly states in his text (p. 209 n.) that he excludes this area from his estimate of our available coal resources, as it is inconceivable to him that the thin and intermittent seams of the carboniferous limestone area in which they occur could ever become available at such necessarily great depths, even if all the upper seams of the true coal-measures were worked out.

In the French work of Fallex and Mairey, this coalfield map appears in a still more unsatisfactory form on p. 133, no distinction being made at all between known and conjectured coalfields, and the town of Berwick is actually made to appear surrounded by one of "the principal coal basins of Great Britain." This last work is on a much smaller scale than either of the two German works noticed, having not only a smaller number of pages, but a page of a much smaller size. It certainly has good points, among which may be mentioned its clearness of exposition and description, its apt quotations, and some of its sketch-maps, diagrams, and other illustrations. It has, however, a rather regrettable number of errors, many indeed trifling, but others more serious. Its account of the European climate and the conditions on which it depends is in one or two points fundamentally faulty. To say that English sheep furnish only a small quantity of the wool required by the woollen industry of the "West Reading" of Yorkshire (p. 137) never was true. Certainly the great part of the raw material comes, as stated, from Australia, but it is only quite recently that South America, which is also given as a principal source of supply, has come to furnish us with any considerable quantity, and it has never supplied us with as much as our own sheep, or even as much as South Africa, which is not mentioned. To single out shawls as the sole speciality of the Glasgow textile industry is absurd. It is out of date to mention cutlery as the staple industry of Sheffield (p. 122); also out of date to speak of Germany (p. 442) as coming after the United Kingdom in the production of iron. One reads nowhere else of the "ancient abbeys of Balmoral and Abbotsford" (p. 123). A further enumeration, however, might be misleading, as for the most part the compilation appears to be carefully done.

G. G. C.

THE ANCIENT GEOGRAPHY OF EUROPE.

'European Animals: their Geological History and Geographical Distribution.' London: Archibald Constable & Co., Ltd. 1907. Pp. xiv + 258. *Illustrated. Price 7s. 6d. net.*

For his great industry in bringing together such a large number of facts connected with the past and present distribution of the animals of Europe, together

with much valuable geological information, the author of this work (which is based on a course of lectures recently delivered at South Kensington) has earned the thanks of students of both zoology and historical geography. Such an amount of information it would, indeed, be difficult to obtain from any other source.

These facts are, however, but the foundation-stones upon which Dr. Scharff has built a large superstructure in connection with the past distribution of sea and land. All who are acquainted with his previous works will scarcely require to be told that the author has no hide-bound prejudices in regard to the permanency of continents. On the contrary, we venture to think that he is too prone to invocate continental connections when the facts might be much better explained without their aid. Indeed, he appears to us to introduce such connections when they are absolutely contrary to biological evidence.

To confine ourselves to a single instance, we may take the chapter devoted to Scandinavia, in which the author endeavours to prove that the Arctic animals of western Norway, such as the reindeer, effected an entrance into the country by way of a land-connection with Greenland.

That there was a former land-bridge after the first great (Scandinavian) glaciation connecting northern Scotland with western Norway north of lat. 59° may be freely admitted, and likewise that this was the route by which the animals in question reached the latter country. This, however, is a very different matter from a connection with Greenland, in regard to which two well-known American writers recently expressed their astonishment at the meagre details upon which such sweeping generalizations were based, more especially as the so-called facts are far from certain.

The hypothesis renders it, of course, necessary to assume that reindeer were originally American animals; but, as Mr. Madison Grant has observed in his excellent paper on the "Origin and Relationship of the Large Mammals of North America" (1904), there is every reason to believe that the entire deer family originated in the northern continent of the Old World, whence a small contingent entered the New World by a land bridge across Bering strait. Since, so far as we are aware, there is not a single fact which militates against this belief, the theory of an immigration of the reindeer from Greenland into Scotland and Norway, and consequently of a dual origin for the animals of Western Europe, is shattered. Indeed, unless the belief in the Old-World origin of the deer tribe can be proved false, it is in the highest degree improbable that there has ever been any late land-connection between the eastern and western hemispheres except across Bering strait.

In place of the reindeer coming from Greenland, there is, as Dr. Stejneger (*Smithson. Miscell. Coll.*, vol. **48**, pp. 503 and 513 (1907)) has remarked, good reason to believe that the so-called Atlantic fauna of Scotland and western Norway was derived from Central Europe, entering Scotland towards the close of the great glaciation, and thence reaching Ireland first and afterwards Norway.

As criticisms of a somewhat similar nature might be urged against several of the author's theories, it is evident that while the book is a valuable storehouse of facts connected with the distribution of European animals, yet it can scarcely be accepted as a trustworthy guide to the form of the European continent in prehistoric times. Perhaps one of its greatest faults is the confidence with which these ill-supported generalizations are given to the world. R. L.

Capri.

'The Book of Capri.' By Harold E. Trower. *Illustrated.* Pp. xxviii. and 345. Naples: Emil Prass. 1906.

This is a very full and eminently readable *Guide raisonné* to Capri, written for the most part by the British Consular agent, who has spent over ten years on the

island. He has had the help of Mr. Silva White in the chapter on climate, of Dr. I. Cerio in that on geology, and of Mrs. Longworth Knocker in that on flowers. Other contributions also are acknowledged in the concluding chapters, which are in the nature of appendices relating romantic incidents connected with the place. The author gives a bibliography, and has evidently taken great pains to include both in that and in his text all kinds of recent information and research. The book will add greatly to the interest and pleasure of any one visiting Capri, and especially of any one who makes a protracted stay; and it is not the less suited to its purpose for being written in a popular style, and including a good deal of matter not to be expected in an ordinary guide-book.

ASIA.

Formosa.

'Japanese Rule in Formosa.' By Yosaburo Takekoshi; with Preface by Baron Shimpei Goto, Chief of the Civil Administration. Translated by George Braithwaite. 8vo. *With 38 Illustrations and a Map.* Pp. 342. London: Longmans, Green, & Co. 1907. *Price 10s. 6d. net.*

Baron Goto, in introducing the author of this volume to his readers, complains that, while the Japanese administration of Formosa has been severely criticized, the majority of the critics have never visited the island, and are singularly ignorant of the conditions now obtaining. And if this be true of his fellow-countrymen, it must be admitted that we in England have, if anything, still less knowledge of the island than they, for previous to the Japanese occupation few persons besides naval officers and wandering naturalists had set foot upon its shores. The present volume may therefore be said to be especially useful, for even now books treating of Formosa are exceedingly limited in number, and not many of their authors have had such opportunities as Mr. Takekoshi, who, in addition to making extensive journeys about the country, has had access to most sources of official information in his capacity of member of the Japanese Diet.

The book bears evidence of being rather hastily put together, and contains some rather bizarre English, but it is not lacking in information. Mr. Takekoshi is evidently chiefly interested in administration and politics, and hence we have special chapters on finance and economics, the relation of landlord and tenant, police administration, education, the courts of justice, and the question of the three monopolies—salt, opium, and camphor—as well as some sixty pages on the past history of the island, but matters geographical are by no means unrepresented. It is true that, when speaking of the fauna and flora and geographical distribution, the author is far from being at home, and seems to be ignorant of the work of Swinhoe, Adams, and other naturalists—or perhaps we ought to say to know them only by repute, for they are mentioned in the bibliography; but his chapters on the development of the island's resources, on the Formosan savages, on tea and other leading products, and on communications, trade, and harbours, are nevertheless full of information. Mr. Takekoshi has a strong admiration for the British and their methods of rule, and he would like to see the less-known parts of the island put in the hands of one or more chartered companies for some twenty years or so.

It cannot be laid to the charge of the Japanese that they have not troubled to make themselves acquainted with the land and the people that have come into their possession. The whole area of Formosa has now been accurately surveyed and its productive capacity ascertained, and there is no field or plantation, however small, which will not be found upon the map. Eight hundred officials, conducting inquiries into customs, ownership, etc., worked side by side with many corps of engineers

until the survey was completed. The number of savages—who, it may be mentioned, occupy nearly half the island, and that, it is believed, much the richest in timber, gold, iron, and oil—is placed at 104,000. The two specialists, Messrs. Ino and Kurino, who were detailed by Government to report on these people, divide them into eight groups, each having its own peculiar language and customs. These are the Atayal, Vonum, Tsou, Tsalisen, Paiwan, Puyuma, Ami, and Pepohoan. Of these, in addition to various details of their distinguishing characteristics, etc., Mr. Takekoshi gives type photographs, but they cannot be said to be entirely satisfactory, for two of them—the Atayal man and the Paiwan woman—have certainly a very large admixture of Chinese blood. Some interesting statistics are given of the climate, rainfall, etc., and also of the camphor industry. There is, unfortunately, no index, but the omission is partly atoned for by a tolerably full and careful bibliography, albeit somewhat unnecessarily full of misprints and errors. That the author has not himself consulted all the works mentioned is probable. One of them is given as "'Formosa' by the author of 'Anonyma.'" We are unacquainted with the book in question, but without undue rashness we may hazard the surmise that it deals with another world than that of which Mr. Takekoshi writes. F. H. H. G.

AFRICA.

The Egyptian Sudan.

'The Egyptian Sudan: its History and Monuments.' By E. A. Wallis Budge. 2 vols. *Illustrated*. Pp. xxviii., 652; x., 618. London: Kegan Paul & Co. 1907.

We do not pretend adequately to review this large and important work here. As its sub-title implies, the staple of its matter and the ground of its merit lie outside the field of geography. What comes within the purview of this *Journal* is of less importance than the rest, and not so largely based on first-hand observation and research. We find a useful chapter of travel-bibliography at the outset, the result of considerable labour, and in the long catalogue note but one slip. "The eminent traveller Niebuhr (born March 17, 1733, died 1763) who visited Egypt in 1761" is Carsten of that ilk; but he lived to be about fourscore years of age. The date 1763 is that of his return to his native land from Yemen, not the date of his death. Further, there is a summary survey of all the Sudanese provinces and their inhabitants, with certain remarks on racial types and social customs. In the northern riverain Sudan this is enriched by the author's own observation. The rest is taken in the main from recent official works, such as Count Gleichen's 'Handbook' and Sir W. Garstin's Nile Bluebook, and is not intended for geographers, but for those to whom the original sources are inaccessible or distasteful. Lastly, there are scattered up and down the two volumes many notes and impressions of the aspect of the northern Sudan just after the close of the Mahdist period. These have a historical value which is enhanced by the privileged position and undoubted competence of the observer. Dr. Budge's knowledge of Arabic and long familiarity with Nilotic scenes and peoples gave him a great advantage over the special correspondents and the like who have hitherto been our chief authorities for the appearance of the Sudan during and immediately after Kitchener's advance. It should be added that pretty nearly all that is known concerning the ancient geography and topography of the Nilotic Sudan is to be found somewhere or other in the book; but so far as we have been able to discover, no new local identification is adduced, and Dr. Budge confines himself in this connection to the river valley. The great body of the book is outside our scope. It deals very fully with the ancient history of the Sudan, and more summarily with the modern.

There is a very careful description of all the extant antiquities, both those now in the country and those that have been removed. And embedded among these scientific chapters is the material for an excellent travel-book. We venture to think this matter would have been better used apart. It appeals to different readers and to an incongruous mental phase. Its intermixture with the scientific chapters will rob it of all but a small proportion of its due audience; and the scientific matter also suffers in its turn. The public is doubtless wrong, but nothing cures it of a vague distrust of the scientific between the same covers as the popular. It cannot bear uncertainty as to how it stands with an author, and is suspicious of literary versatility. Dr. Budge's 'Travels and Discoveries' would have been one of the successes of the season. Dr. Budge's 'History of Nubia and the Sudan' would have found many hundreds of serious readers and remained an indispensable book of reference. Dr. Budge's 'Compendium,' embracing the matter of both those books, will not reach a tithe of their potential public.

Races of Nyasaland.

'The Native Races of the British Empire: British Central Africa.' By A. Werner. London: Constable. 1906. Pp. xii., 303. Size 9 × 5¼. *Price* 6*s*.

This book more than upholds the promise of the other volumes of the series. Miss Werner has the advantage of an intimate acquaintance with the natives of whom she writes, having lived amongst them for some years. Consequently she can treat of them with a real sympathy, and her book lives in a way which those written by the man at home, however well he may know his subject, can never do.

The natives treated of by Miss Werner are those living on the Shiré and around the west of Lake Nyasa, as well as some dwelling in what is politically North-Eastern Rhodesia. The book follows the plan laid down for the series, there being chapters on Magic and Religion, on Native Life and Industry, and on the inhabitants generally. Probably the most valuable chapter is that on Language, as Miss Werner has made a life-study of African tongues, but it is rather difficult to understand why musical instruments should have been included under this heading. In the chapter on Folk Stories Miss Werner points to the connection between these African stories and the Uncle Remus tales, a connection now generally accepted, while in that on Traditions and History, there is a useful account of the migrations of the tribes. The book has the advantage of a glossary of native words and of a map, which, however, might have been larger. The book is well illustrated, but in a few cases more care might have been taken in the arrangement of the photographs on the plates.

POLAR REGIONS.

Peary's 'Nearest the Pole.'

'Nearest the Pole.' By R. E. Peary, U.S.N. *With* 98 *illustrations and* 2 *maps.* London: Hutchinson & Co. 1907.

Commander Robert E. Peary ranks among the greatest Arctic explorers: as a traveller with dogs and Eskimo he is superior to all others. Let those who have not followed his footsteps during the past fifteen years turn to the map which accompanies this volume. From the 77th to the 87th parallel of latitude, 600 geographical miles of frozen land and water, and across 70° of longitude, Peary's tracks show on the chart like the meshes of a spider's web. Over the inland ice of Greenland to the northern extension of that island continent, across Ellesmere

Land, Grinnell Land, Grant Land, and his last and greatest effort across the polar ice to within 174 miles of the northern apex of our Earth!

Be it remembered that during the twenty years Peary has been exploring the Far North, he has received no financial support from his national treasury. The funds supporting his earlier expeditions were derived from his limited resources, the aid of a few friends, and grants from some of the scientific societies of the United States. Later, a few ardent admirers founded the Peary Arctic Club to further polar exploration under their distinguished countryman. It was with the aid of this society that Peary undertook his expedition of 1905–6. In 1904 the Peary Club decided to build a ship suited for Arctic exploration. All that scientific American ship-building could devise is claimed to be embodied in the *Roosevelt*, and Peary expresses his conviction that she has been proved the best ship ever built for Arctic work.

The *Roosevelt* left New York on July 16, 1905. The crew numbered twenty, six being citizens of the United States; the remainder, including sailing-master and mate, natives of Newfoundland. After a favourable voyage through Davis strait, Baffin bay, and Melville bay, the *Roosevelt* on August 7 arrived off Cape York. Landing there, Peary is once more amongst those he styles "my Eskimo," "my faithful people." These, the most northern dwellers on the Earth, are a small clan, probably never exceeding an aggregate of 400 individuals, living along the west coast of Northern Greenland. Fenced in between the ice of Melville bay and the great glaciers to the north and the inland ice, this small community, probably for ages, had been cut off from intercourse with the rest of mankind. Discovered in 1818 by Captain Sir John Ross, they were subsequently brought to notice by Kane, Hayes, and Bessels, who in different years wintered in their territory, and who have given many accounts of their natural good qualities and their superlative attainments as dog-sledge drivers and hunters in their frozen world. It is to Peary, however, we owe the most remarkable conjunction of effort between the scientist and the savage that the records of Arctic exploration afford. The white man, saturated with the one ideal—exploration of the polar regions, planned to make these Eskimo his allies. He lived amongst them summer and winter, he became their friend. His wife joined him, and their daughter was born in their midst. Great must be Peary's magnetic influence over these children of Nature. They follow him with all the faithfulness of their own dogs, those invaluable animals which have been the bed-rock of Peary's triumphs. They pass with him without question into remote lands; he tells them to go forth into the "Great Night" and bring back food, and they do so; they follow him over the polar pack, rendering service impossible from white men. Herein Peary has full reward; he gathered to his fold these children of the snow, and by their aid wrings tribute from the "Ice King."

No time was lost in collecting the Eskimo deemed necessary for the campaign. At midnight of August 16 the *Roosevelt*, with an addition of over fifty natives—men, women, and children—with their belongings, and 200 dogs, swung out of the harbour of Etah, and now commenced the struggle for which she was built. The fierce battles with the heavy polar ice of Smith sound continued for twenty days, but on September 5 the *Roosevelt* rounded Cape Union and lay along the northern shore of Grant Land at Cape Sheridan, some 2 miles beyond the winter quarters of the *Alert* in 1875–76. Peary claims to have distanced his predecessors—a small matter—but had he consulted the narrative of Sir George Nares, he would have found that that able navigator pushed the bluff-bowed *Alert* to Cape Sheridan, but, considering that position too exposed, fell back to "Hoeberg Beach." Cape Sheridan proved an unsatisfactory winter quarter. The coast-line there is exposed to the full force

of the polar pack pressing on shore, but Peary had come to the limit of navigation for the season, and he determined to cling to the highest point reached. His ship passed through many and great dangers during the autumn and winter, but came through her trials uninjured, as did the *Alert* thirty years before. Peary at once sent his Eskimo hunting; they dispersed over this land of desolation from Cape Joseph Henry to as far south as the Lake Hagen district. From that time until February of the next year, the dogs and the greater part of the natives remained away from the ship, only returning with meat during the periods of full moon. Some 200 musk-oxen and reindeer were secured, probably as many hares, and salmon-trout from Lake Hagen. Thus Peary, with the help of his Eskimo, was abundantly supplied with fresh food. Under similar conditions white men are restricted to a narrow circuit around their winter quarters. Unfortunately, great mortality occurred amongst the dogs.

On February 19, 1906, the first sledge-party left the *Roosevelt* for Cape Hecla. Three days later the entire party for the attack on the pole was there assembled: six white men, Henson, and twenty-one Eskimo with 120 dogs—the personnel for one main and five or six supporting parties. By March 6 Peary had started all his auxiliary sledges on the ice, and on that date he himself headed northward from the land over the polar pack. The usual obstacles were encountered and overcome, but in lat. 84° 38′ Peary was brought up by a broad lead of open water, extending for miles east and west, which he thinks is a more or less permanent crack between the land-ice of Lincoln sea and the polar pack. From there Peary sent back his auxiliary sledges for supplies; but seven precious days were lost, and it was not till April 2 that he and Henson were able to cross this great lead, though the temperature registered from −60° to −66° Fahr. Pressing north with Henson, every conceivable difficulty of ice-travel was encountered; but Peary remarked, "My little brown children of the ice tooled their sledges through it with the skill born of life-long experience." On April 4 terribly stormy weather came on, which obliged the party to build igloos, and shelter themselves within. No men could travel in such a storm; it was a physical impossibility even for Eskimo. Six days was Peary detained in Storm camp. The gale moderating, these determined men still pushed northward—eight in all. The conditions of the ice became better for travelling. The worn-out dogs were killed, and fed to the others. During the last days of the advance, Peary by desperate effort was making rushes of between 20 and 30 miles a day. On April 21 the latitude of 87° 6′ was reached, and Peary knew he had shot his last bolt, and that he must endeavour to retrace his steps. Forty-seven days had Peary been on the polar ice, for twelve detained by open water and unprecedented weather. Eliminate these unlooked-for causes of detention, and there can be little doubt Peary would have reached the North Pole. It was a great attempt, and fought to the very limit of human endurance. The sufferings and trials of the return were as great, if not greater, than those encountered in the advance. The fierce storms and shifting of the ice had obliterated the trail. It was Peary's hope that his supports might have brought forward and left supplies at Storm camp. In this he was disappointed. From there he set a "bee-line" course for the Greenland coast. He alone of the party knew how far the eastward drift of the pack had taken them, and that salvation lay in Greenland and its musk-oxen. To their horror, after a few marches they again found the great lead of open water some 2 miles in width. Delayed at its brink, each day the number of the dogs dwindled, and sledges were broken to cook the animals they ate. At last a film of young ice formed over the lead, and they crossed on their snow-shoes as if by a miracle. After great vicissitudes, they crawled on to the northern coast of Greenland at Cape Neumayer. With astonishing good fortune, just before landing they crossed a fresh sledge-trail;

it proved to be that of Clark and his three Eskimo; one of the supporting parties drifted likewise to the eastward. Peary finds them perishing, but saves them. It was weary travel for these starving men along the north shores of Greenland. Fortunately a small herd of musk-oxen were met with, and all secured. This probably saved the lives of the entire party. At last Robeson channel was crossed and the *Roosevelt* regained. Unfortunately, Peary gives no dates in his narrative after his turning back on April 21, but the return appears to have been in the last week of May. After resting a week on board, the indefatigable traveller again set forth, with thirty-nine dogs, the residue of one hundred and twenty with which he commenced spring operations. On June 8 Peary is at Cape Columbia. There on its summit he builds a cairn, displays the Stars and Stripes, and leaves a record with a piece of the flag. This is very proper; but Peary might have reminded us that, thirty years before, Aldrich unfurled the Union Jack on this the most northern point of the American continent, and that Nares gave it the name it bears. In 1876 it took Aldrich twenty-three days with man-hauled sledge to reach Cape Columbia from Cape Sheridan. Peary, with dogs and Eskimo, covered the same distance in six. Nothing can ever belittle the stupendous work of British sailors dragging their sledges for thousands of miles of Arctic travel; their bravery, their constancy, their hardy virtues, remain a national heritage for all time, but the old order changeth.

Now the short summer episode is reaching its zenith, and the lately frozen earth turns into knee-deep mud, the snow is slush to the hips, the floes are covered with deep pools of water, and crawling icy-cold streams are the pervading surroundings. The difficulties of summer sledging are little less than those encountered in the polar spring. Through all this Peary plods his way; he passes Aldrich's "farthest," and joins hands with Sverdrup to the south, completing the circuit of the coast of Grant Land. Crossing Nansen sound, he lands on Axel Heiberg Land, and from it makes the chief discovery of the expedition. Far to the north-west he descries new land, lying approximately in 83rd degree of latitude—an interesting discovery, proving that the continental shelf fringes the polar basin greatly to the westward of Grant Land, and giving indications that there are still realms to conquer in the unknown area of the Beaufort sea. Peary's return journey to the ship, over decomposing land, ice, and snow, was very trying. The *Roosevelt* broke out of her winter quarters on July 4, and after a long and perilous voyage of five months, during which she was sadly mauled by the Smith sound ice, reached New York harbour on Christmas Eve, 1896, without a single casualty amongst the members of the expedition. Peary thus sums up the results obtained: Attainment of the "highest north;" Determination of new land north-west of Grant Land; the widening of our horizon as regards ice-conditions in the western half of the polar sea; the connecting of the unknown coast between Aldrich's farthest west in 1876 and Sverdrup's farthest north in 1902; the determination of the unique glacial fringe and floeberg nursery of the Grant Land coast. It is regrettable that Peary did not, or could not, carry a sounding apparatus on his northern journey; a reliable sounding in the 87th degree would have been of incalculable value, and a fitting adjunct to a great adventure.

H. W. F.

THE MONTHLY RECORD.

EUROPE.

Alpine Plants on Scottish Mountains.—It is still a doubtful question how far the occurrence of plants of restricted distribution, such as those of mountain summits, is determined by the chemical constituents of the rocks on which they grow, some holding that there is an intimate connection between the plants and rock-constituents, while others lay greater stress on other conditions, such as exposure, water-supply, etc. The latter view is adopted by Mr. Peter Ewing in an address to the Natural History Society of Glasgow lately printed (*Transactions*, vol. 7 (N.S.), part 3). He bases his conclusions on the alpine and arctic plants found on the summits of Ben Lawers and other Scotch mountains, and though his line of argument is not so clear as might be wished, the close acquaintance which he shows with the distribution of the plants in question gives some weight to his opinion. The district in question is traversed by a belt of what are known as phylite schists, and it is on these that many of the rarer alpine plants are found. But no definite law of distribution can be laid down. On comparing the mountains at the extreme ends of the schistose belt—Ben Lawers and Beinn Laoigh—it is found that the species are by no means identical. The latter mountain is partly formed of mica-schists, which are in places particularly rich in alpine plants owing to abundant moisture and shelter, while some parts of the phylites are barren owing to lack of moisture. A typical arctic plant—*Arabis petræa*—is found all over the mountain, whatever the rock-outcrop may be. Many instances are given of erratic distribution. Thus *A. alpina* is found only on basalt in Skye, though in other districts it occurs on granite, gneiss, syenite, and trap. Even if plants appear to grow better on some rock-formations than on others, this may—the writer thinks—be due to many other causes than chemical composition, *e.g.* the occurrence of pockets which provide good foothold, the power of holding water, the method of decomposition of the rocks, and so forth. The question is well worthy of further investigation.

The Lakes of the Berlin District.—An interesting study of the physical features of the district immediately west of Berlin, and particularly of its intricate system of small lakes, is contributed by Prof. F. Wahnschaffe to the *Naturwissens. Wochenschrift* for May 26, 1907. As is well known, the present features are mainly the result of the action of the great ice-sheet of the glacial epoch, which had its southern front about this latitude, and has left copious traces of its presence in its ground moraines and the deposits (mostly sands) laid down by the waters derived from its melting. The great streams of this period have left their mark in the great valleys, such as that in which Berlin is placed, which runs west-north-west, and can be traced from the Oder to the Elbe. They are bounded by stretches of higher ground, largely composed of drift, with a slightly undulating surface broken here and there by hollows, which either occur singly or lie in rows in narrow furrows. The existing streams only utilize in part the beds of the old river-courses. Thus the system of the Havel, in Prof. Wahnschaffe's opinion, is a much younger formation than the Berlin valley, as the connecting portion of its course between the Eberswald and Berlin valleys bears a much more recent character than the portion further south, where, to the south-west of Berlin, it passes through a succession of narrow lakes occupying a furrow in the diluvial plateau, and showing remarkable variations of depth, the deeper places being probably the remnants of larger expanses of deep water which have been in great part filled by sediment. The sandy tract of the Grunewald separates the lakes of the Havel from a smaller

series to the east, known as the Grunewaldseen. It is evident that neither of the chains of lakes can have been hollowed out by the existing watercourses, but that the hollows which they fill date from the time of the last ice-sheet, the irregularities in their beds being probably due to the work of water flowing under the ice. Since that time parts of the depressions have been filled up by the formation of peat, and the last part of the paper is devoted to a consideration of the different types of moor represented, the district affording unusual opportunities for studying the whole process of moor-formation through all its stages.

Anthropogeography of Lower Austria.—Dr. O. Firbas has written a comprehensive monograph (*Forschungen zur deutschen Landes u. Volkskunde*, vol. 16, No. 5), illustrated by eight maps and twenty-three cuts, in elucidation of one "viertel" of Lower Austria—that known as "Under-the-Manhartsberg." Viewing the present population as the resultant of all the forces that have gone to the making of it, the author, taking but subordinate account of historic traditions, has directed his attention the more to the present conditions of the domain as compared with those of neighbouring lands, so as to arrive, geographically, at a determination of the genesis of its population. "Under-the-Manhartsberg" is bounded north and east by the frontier line, on the south by the Danube, on the west by the steep slope of the Manhart mountains, where the boundary-line follows the contour of 1000 feet. The "viertel" has an area of 1794 square miles and a population of 377,972. The detailed geology of Weinland—still mostly virgin-ground—the author reserves for a future task. Yet the monograph brings out in broad characters the determining influence of the geology on the anthropology of the region. The other physical factors taken into account include genetic morphology, climate and vegetation, while on the anthropological side the author investigates the bodily characteristics of the population, its intellectual products—more particularly language—the local nomenclature, house-building, and settlements, and inquires how far these elements are an indication of anthropological types. Of highly popular, as well as scientific, interest is the chapter on types. A broad strip along the south bank of the Danube, stretching from Bavaria eastwards, is the most faintly streaked by the blond type. Scheibbs and Lilienfeld districts, *e.g.*, have but 17 per cent. blond. South-east of this is a blond island from Baden *viâ* Neunkirchen to Bruck. North of it, too, is a rather blond strip running parallel to the Danube; and to the north of this, again, south of the Thaya, we find the greatest proportion of blondness. As a rule followed with the uniformity of a law of nature, the writer postulates that in Central Europe the people of pure protomorphic type always constitute together about 40 per cent. against 60 per cent. of mixed metamorphic type, and this rule applies to the whole territory between the Baltic and the Adriatic, where white and brown struggle with one another for the mastery. In Lower Austria, *e.g.*, the sum of the two pure types makes 43·9 per cent. This phenomenon is accounted for by the fact that the longer two types dwell together in one habitat the more will they become mixed, whereas the shorter the period of their cohabitation the more will the protomorphic types prevail. The proportion of protomorphic to mixed type in one locality may accordingly be taken as a fair indication of how long the mixed type has been in process of formation.

ASIA.

Dr. Longstaff's Ascent of Trisul.—A few further particulars respecting Dr. Longstaff's ascent of this peak (*cf.* August number, p. 211) reached this country towards the end of July. It appears that a base camp was established at the mouth of the Trisul nullah, at about 11,100 feet, the party afterwards moving to a higher

camp at about 16,750 feet. The travelling had for some days been very rough, and the weather inclement. On June 12, Dr. Longstaff started for the summit, accompanied by the Brocherels and by Jemadar Kabir Burathoki, of the 5th Gurkha Rifles. By noon a height of 20,500 feet was reached, the going being steep but easy on about 6 inches of snow. The slopes continued steep but easy up to the summit, which was reached at 4 p.m. in the teeth of a bitterly cold wind. The party regained their tent soon after 7 p.m., and returned to the base camp on June 13.

New Expedition to the Tian Shan.—We learn from the *Geographische Zeitschrift* that Prince Arnulf of Bavaria, third son of the Prince Regent Luitpold, set out for the Tian Shan in April last, accompanied by Dr. Merzbacher, the geologist Dr. Leuchs, and one or two other Europeans. The prince's object is mainly sport, but Dr. Merzbacher hopes to continue his well-known scientific investigations into the morphology and other features of the range. The final organization of the expedition was to take place at Kulja, and the travellers expected to be home before the end of the year.

AFRICA.

The Increase of the Water-supply of Egypt.—A despatch from Lord Cromer, written shortly before his retirement, and since printed as a parliamentary paper (Cd. 3397, Egypt, No. 2, 1907), sums up the results of the studies by Sir W. Gastin, Sir B. Baker, and others, which have led to the decision to increase the water-supply of Egypt by raising the height of the Assuan dam 7 metres, or some 23 feet. It is pointed out that an enormous benefit is now known to have been conferred on Egypt by the existing dam, the sale value of the lands already irrigated through its means having increased by over £24,000,000. But the reservoir supplies only about a quarter of the water needed by the country, so that there can be no doubt as to the advisability of an increase. This could be brought about either by further storage in reservoirs, or by preventing the waste in the Bahr-el-Gebel marshes, and the result of careful inquiry has been to show that, if the whole of the needed supply is ever to be obtained, it will be necessary to make use of both methods. Before deciding on the best means of adding to the storage capacity, a careful examination of those reaches of the river between Wadi Halfa and Khartum was made by survey parties acting under the direction of Captain Lyons. Only three such reaches seemed to fulfil the necessary conditions, viz. those from Khartum to Hagar-el-Asl, from Berber to Shirri island, and from Abu Fatma to Wadi Halfa. The result of the surveys was to produce excellent detailed maps of these three reaches, the rocks being also carefully examined, but they have also shown that no site exists which can be recommended for the construction of a new reservoir. The raising of the Assuan dam was thus the only course left open, and though this involved the submersion, during a portion of the year, of the temples at Philæ, it was felt that it would be unjustifiable to save these by sacrificing the present and future interests of the people of Egypt. All possible steps will, however, be taken to minimize the possible injury to archæological interests, and the following measures are laid down as necessary for this end: (1) The conservation of such structures as may be wholly or partially submerged, by the consolidation of their foundations; (2) Repair and reconstruction of the upper portions of these where such is advisable; (3) the systematic study of the ancient structures, sites, settlements, cemeteries, etc. The question of the raising of the dam has been exhaustively studied by Sir Benjamin Baker from an engineering point of view, with the result that all difficulties were at last met, and the storage of nearly two and a half times the present quantity of water proved perfectly feasible and safe.

Port Sudan and its Trade.—A Consular Report (Annual Series, No. 3755) records the progress made in the transformation of Port Sudan, and in the development of its trade. Lying 35 miles north of Suakin, it is protected from heavy seas by reefs, and, as a port of entry and forwarding station, has superseded Suakin. Besides its sea communications, it is in railway communication with the Atbara, Khartum, Wady Halfa, etc. The inlet, which is 500 yards wide for the first mile, then expands, on the south side, into a basin 900 by 500 yards, with a minimum depth of 6 fathoms. The channel continues 2 miles further up, with a basin on the north side and one at the end. The inlet has a minimum depth the whole way up of $2\frac{3}{4}$ fathoms, and its narrowest part is over 70 yards wide. On the north side are the railway terminus and custom house, and quays in process of construction. When completed, the quay will be $1\frac{1}{2}$ mile long, accommodating twelve to fourteen ships, and before long the port will be as well equipped as Alexandria. A bridge, available for every kind of traffic, is to unite the two parts of the port, and will open to give access to the upper waters, where a dock has been begun. The port will become an outlet, not only for the Sudan, but also for the greater part of Abyssinia and the Congo State. The returns already show a notable increase in the trade of the port.

Surveys in Somaliland.—A note in the lately issued report of the Board of Scientific Advice for India (1905–06) deals with recent explorations in Somaliland. In 1903 Captain Beazeley, R.E., of the Indian Survey, accompanied the Somaliland expedition, and succeeded in surveying 15,000 square miles on the 4 miles to 1 inch scale. He describes the region as one vast bed of limestone several thousand feet in thickness. The surface rises at a uniform slope of 10 feet a mile from the south-east coast-line, and attains an elevation of 3000 feet where it abuts against the mountains of Abyssinia. Somaliland is thus a tilted plateau. The drainage of the south-eastern mountains of Abyssinia is across Somaliland, but all these streams disappear before they reach the sea. The Webbe Shebeli, for instance, has a considerable volume of water derived from the Abyssinian snows, and it maintains its course in Somaliland for upwards of 700 miles, but it loses itself in sandy soil 20 miles before reaching the coast. There is a curious and well-marked underground system of drainage which supplies wells all over the country. An impermeable stratum appears to exist 60 or 70 feet below the ground surface, and when wells are deepened below this their water disappears. The Der river has a distinct bed for 150 miles, but it then vanishes in marshy ground; after remaining hidden for 100 miles it reappears at the surface and flows to the sea under the name of the Dun. The present inhabitants of Somaliland are nomads, who expelled the Gallas, the former inhabitants. The latter irrigated and cultivated the land, but all traces of their civilization are dying out, for the nomads make no attempt to cultivate, and to this the decadence of the country and the diminished rainfall are ascribed.

Earth-movements in South Africa.—Prof. E. H. Schwarz, whose contributions to the physical history of South Africa have frequently been referred to in the *Journal*, has lately called attention to the rock channel of the Buffalo river at East London as supplying evidence of an undoubted submergence of the land, in a region which has been equally certainly subject to general emergence, as witnessed by beach-covered flats at elevations of 200 to 400 feet above sea-level (*Records of the Albany Museum*, vol. 2, No. 1). The data proving the existence of this rock-channel (which are embodied by Prof. Schwarz in a diagram) have been obtained from borings made under the direction of Mr. J. J. Godfrey for the purpose of testing the foundations of a railway bridge. They show that the channel was cut in rock consisting apparently of shales and sandstones of the Beaufort series, and after

being submerged about 122 feet, has been filled in with sand and mud. In three bore-holes gas was struck, which in two cases escaped with explosive violence. It is doubtless due to the decomposition of organic matter contained in the clay.

Ethnological Research in the Interior of South Africa.—The well-known traveller, Dr. Rudolf Pöch, has been commissioned by the Imperial Academy of Sciences in Vienna to make anthropological and ethnological investigations amongst the Bushmen of South Africa, for which country he is to start in October. His stay among the Bushmen will probably last for one and a half to two years. Pöch will follow up the investigations of Fritsch, Burchell, Campbell, Moffat, T. Hahn, W. H. J. Bleek, and S. Passarge, being guided, however, in his procedure by the expeditions of Prof. Alfred C. Haddon (Cambridge) to the Torres Strait islanders and of Prof. Baldwin Spencer (Melbourne) to the natives of Central Australia. He will be the first trained observer to work on the spot among the free Bushmen. As he did among the Papuans of New Guinea, he will here too, among other things, take phonographic and cinematographic sketches of life and manners. The main problem, however, calling for solution is the precise determination of the relations of the Bushmen to the Hottentots. These two constitute a group of people distinguished as Koikoin, a group standing in contrast to that of the Bantu. The field of his activity will be the Chanse Veld, the seat of the tribes of Bushmen that have kept themselves, down to the present time, pure and unmixed, the tribes of the Aukwe and Kung. The Chanse Veld lies in British Bechuanaland, south-west of Lake Ngami, towards the frontier of German South-West Africa. It is known as one of the most extensive fertile tracts, with constant water-supply, on the edge of the Kalahari desert. After the railway journey from Swakopmund to Windhoek, the route runs by way of Gobabis and Rietfontein. Here is a "permit," a spot where it is allowed to cross the border. At this point Dr. Pöch will set foot on British territory, and in Kwachara[3] nei ("3" denoting one of the well-known clicking sounds), the westernmost place in the Chanse Veld, enter on his investigations. In the German colony he will have, as basis of comparison, the Nama and other Hottentot tribes. Having completed his tasks in the Chanse Veld, Dr. Pöch will possibly proceed further east to the Botletle and thence to Palapye and Mafeking.

French West Africa.—A Consular Report (Annual Series, No. 3763) supplies some information respecting the progress of French West Africa. It is now decided that the Trans-Saharan telegraph is to strike the Niger at Burrem. A new line, 1075 miles long, is to run from Timbuktu to Burrem, and thence to Niame and Zinder. Connected with the Trans-Saharan line, the new line will bring into the telegraphic system the region between Zinder and Lake Chad. Not less active is the progress of railway communication. A preliminary survey has been made of the Thies-Kayes railway. The Konakri-Niger railway is now opened to traffic for 138 miles, and the remaining 48½ miles are expected to be completed this year. From the terminus at Col de Kumi, 2333 feet high, a railway line will reach Kurussa probably in 1910. Opened last January to traffic as far as Eri Makionye (47½ miles), the Ivory Coast railway is constructed 4 miles farther to Aniebos river, over which a bridge is being built. In Dahome the permanent way was, in 1906, completed to Save, north of the Weme, the bridge over which is finished. The line may be opened to traffic this year. The Porto Novo—Sakete tramway, to open up the district between the Weme and the Lagos frontier, will be ready for traffic early in 1908. As regards agriculture, a reorganization of administration is contemplated with a view to uniformity of policy throughout French West Africa. A fishing station and a permanent lighthouse are to be set up at Cape Blanco, while the interests of agriculture and the fisheries are to be looked after by experts on the spot.

AMERICA.

The Recession of Niagara.—We alluded in the *Journal* for February last (p. 227) to Prof. J. W. Spencer's recent survey of Niagara, the preliminary results of which had been published in the summary report of the Geological Survey of Canada for 1905. We have since received the report by Dr. G. K. Gilbert on the rate of recession of the falls, as deduced from a survey made in 1905 by Mr. W. Carvel Hall, under the auspices of the United States Geological Survey and the State Engineer of New York, the results being compared with those of four previous surveys by official organizations in the United States. As in the Canadian report, the chief attention is devoted to the Canadian or Horseshoe falls, for the recession of the American falls (though considered in its turn) has little effect on the process of lengthening of the gorge. Many of the facts brought out are naturally identical with those recorded by Prof. Spencer, though as regards the conclusions reached, and the manner of arriving at them, some differences are noticeable. The two discussions are therefore useful as checks on each other. Dr. Gilbert wisely insists on the degree of uncertainty which must attach to any statements in the form of definite figures. A difficulty arises from the fact that in one place the recession seems to have been in one direction, at another in another direction, so that confusion arises if different parts are considered separately. He gets over this by assuming one general direction for the recession of the entire central portion of the horseshoe, and by measuring the amounts on lines parallel to this, an average being finally struck. An alternative method deals with the areas intercepted between the crest-lines at successive dates, but here again Dr. Gilbert starts from a line drawn across the river at right angles to what he assumes to be the general direction of recession. In either case he obtains an average annual rate of 5·3 feet for the whole period between 1842 (the year of the first official survey) and 1905. Dealing with the two shorter periods, 1842–1875 and 1875–1905, he finds that the rate was apparently considerably slower during the first than during the second, the figures differing, however, according to the method employed. A good deal evidently depends upon what is assumed to have been the general direction of recession, and the precision of the results must thereby be to some extent affected, especially in the comparative estimate for the two periods. Of late years the movement has been more and more concentrated along a line of weakness which has developed on the eastern or Goat island side of the crescent, and this fact has materially influenced the determination of the general direction for the whole period. For the interval 1842 to 1875 the easterly component was far less important, the greater part of the loss having been on the western side. Much of this loss is entirely left out of account in Dr. Gilbert's calculation, the result being to greatly lessen the rate obtained for the earlier period. Besides the surveys alluded to, Dr. Gilbert has made use of the sketches of both falls taken by Captain Basil Hall in 1827 (which he reproduces), pointing out that they derive some importance from having been made with the aid of the camera lucida. He has taken pains to correlate them with the map of the falls, and the result is to indicate that the central portion of the horseshoe was in 1827 almost exactly parallel with its position at the time of the survey of 1842, though the amount of recession in that interval comes out as less than was to be expected. A question is raised as to the general accuracy of the survey of 1842, which was incorrect, Dr. Gilbert finds, in one particular at least. But he thinks that greater weight must be given to the evidence of the survey than to that of the sketches. In any case, it is safe to assume that the annual rate of recession has been about 4 or 5 feet.

The Navigation of the La Plata.—The importance of improving the conditions of navigation on the La Plata estuary, the main gate of entrance from the outside world to the whole territory of the Argentine Republic, has long been realized. The route hitherto followed by ships of largest tonnage when entering the river is that on the eastern or Uruguay side of the great bank of La Playa Honda, by which the estuary is divided into two main channels. This route threads a somewhat intricate system of passes, with a depth in places of no more than 18 feet. For some time attention was directed to the improvement of this route by dredging and other works, but its disadvantages have of late been more and more realized, and schemes have been set on foot for opening a route on the Argentine side of the great bank. The present position of the question is discussed in an article by Señor A. Mercau in the *Anales de la Soc. Científica Argentina* for December, 1906 (vol. **62**, part 6). The writer gives details of the three most important propositions hitherto put forward for the improvement of navigation. The first is the deepening of the existing route, which is shown to present considerable difficulties, while the length of the route puts it at a decided disadvantage in comparison with the other projects. The second of these is one favoured by the authorities, and consists in the construction of a canal closely following the shore of the river on the Argentine side from La Plata to Buenos Aires, and thence to a point on the Parana de las Palmas, one of the southern branches of the Parana delta. The writer objects to this that it provides no access to the Uruguay. The third scheme is one which he put forward himself in 1900, and which provides for the deepening of the channels on the Argentine side, and their connection with the main mouth of the Parana by way of the Pozos del Barca Grande, side branches also supplying access to the Parana de las Palmas and other mouths. It is claimed for this that it would form the most direct route to the main mouth, and would also give easy access to the Uruguay. The advantage to the Argentine of keeping the main stream of traffic on the western side of the estuary is also emphasized. A plan accompanies the paper, and shows the lines followed by the several routes.

POLAR REGIONS.

The New British Antarctic Expedition.—There have been several changes in the programme of this expedition since Mr. Shackleton outlined his plans in the March number of the *Journal* (vol. **29**, p. 329). King Edward VII. Land has been selected in place of the winter quarters of the *Discovery* as the base of operations of the exploring party. A landing will, it is hoped, be effected by about the end of January of next year, in time to permit of the establishment of depôts to the south before the close of the Antarctic summer. The winter months are to be devoted to the pursuit of scientific investigations in the neighbourhood of the living-hut, and with the return of spring in the latter half of 1908, exploring parties will be sent out southwards in the direction of the pole, south-eastwards into the unknown region at the back of King Edward VII. Land, and east-north-east along the coast in the direction of Alexander I. Land and Graham Land. Nothing definite is known of the geographical conditions in any of these directions, and whether or not the polar contingent succeeds in covering the 700 or 800 geographical miles that will separate the winter quarters from the south pole, the combined explorations of the three parties may be expected to make interesting additions to knowledge of the distribution of land and sea in the Ross quadrant. Each party will comprise three members, while the remaining three of the dozen men who will be landed on King Edward VII. Land, including the biologist and the magnetician, will remain in charge of the hut. In addition to Mr. Shackleton, the landing party will include Mr. James Murray, a biologist who has done

excellent work in the survey of the Scottish lochs under Sir John Murray; Mr. Eric Marshall, the senior surgeon, who has been through a course of training in survey work under the Royal Geographical Society's instructor; Mr. A. F. Mackay, junior surgeon and zoologist; Lieut. Adams, R.N.R., who will be responsible for the meteorological observations; Sir Philip Brocklehurst, who has qualified to take part in the geological and survey work, and will be in charge of the Siberian ponies; and Ernest Joyce, lately first-class petty officer in the navy, who was a member of the *Discovery* expedition, and will have under his care the dogs and sledges. The best of everything has been obtained in the way of provisions and other supplies both for men and animals. Apart from the ponies and dogs, Mr. Shackleton will have for transport purposes a specially constructed motor-car, the value of which will be tested on the southward journey. A motor-launch will facilitate the researches of the biologist, and the expedition will also be equipped with two specially constructed life-boats for the use of the landing-party in case of accident to the ship which is to fetch the explorers from King Edward VII. Land early in 1909. On the return voyage, the course of the vessel will be directed parallel to the patches of coast known as Wilkes Land, and by soundings taken with the object of discovering whether there exists in this direction a continental shelf Mr. Shackleton hopes to determine the continental character of these strips of coast. For this and other purposes, there has been acquired a Newfoundland sealer, named the *Nimrod*, a vessel of 227 net tons, which has been thoroughly overhauled in the East India Company's docks at Blackwall, and rigged as a barquentine. With auxiliary engines of about 60-h.p., the *Nimrod* has a speed without sails of from 6 to 7 knots an hour. The vessel sailed from Torquay for Lyttelton, New Zealand, on August 7 in charge of Lieut. Rupert England, R.N.R., who was second in command of the *Morning* on both her voyages to McMurdo bay to carry relief to the *Discovery*. Before her departure she was inspected by the King and Queen off Cowes, and his Majesty was pleased to confer on Mr. Shackleton the Victorian Order as a mark of his interest in the expedition. Her Majesty also presented the Expedition with a Union Jack, expressing the hope that it would be carried to the South Pole. Mr. Shackleton and most of the members of the landing-party will not leave this country till October, but on board the *Nimrod* are Mr. Murray and Mr. Mackay, as well as Mr. W. A. R. Michell, the ship's surgeon and zoologist. It is anticipated that the voyage to New Zealand by the Cape route will occupy about four months, and during that time, as well as at later stages of the expedition, important magnetic and oceanographical work will be carried out on board. Every 500 miles the ship is to be "swung" for variation, not only on the outward and homeward voyages, but on voyages along the trade routes in the Indian ocean that will be undertaken during the year that the exploring party is on King Edward VII. Land. Charts, chronometers, a compass, sounding apparatus, and other instruments are being lent by the Admiralty; a standard compass and sounding apparatus by Lord Kelvin; and watches by the Royal Geographical Society—while the vessel has been fitted by Mr. Shackleton with a pole compass and a special liquid steering-compass. Dr. David, professor of geology in Sydney University, has promised to accompany the expedition from Lyttelton to King Edward VII. Land, and advise the geologists of the landing-party as to the best means of pursuing their labours.

GENERAL.

The Ninth International Geographical Congress. — Further details respecting the organization of this Congress, which continues to make good progress, are given in *Le Globe*, the publication of the Geneva Geographical Society, vol. 46, No. 2, 1907. It will be remembered that the Congress is to meet at Geneva between

July 27 and August 6, 1908. At a meeting of the Committee of Organization, held in May last, it was announced that three new names had been added to the Honorary Committee, bringing its numbers up to 63. The number of delegations so far named was 48, and that of the communications offered 67. Tickets of membership had already been issued to the number of 62. The most interesting information is that relating to the proposed scientific excursions, the detailed programme of provisional arrangements being printed in full. The definitive programme will be issued in January, 1908. Ten such excursions, some of which will take place before, some after, the Congress, have been arranged for, each being conducted by a competent scientific expert. Some will occupy 8 to 10 days. Between July 20 and 25 Dr. J. Früh of Zürich will lead a party of not more than twenty, for the study of the morphological phenomena of the Alps and their foothills. Another party of the same size, conducted by Dr. Lugeon, will study the phenomena of inverted folding in various parts of the Alps, between July 17 and 25. An excursion of a week, also before the Congress, will be devoted to high-level forestry, and will be led by M. Ernest Muret. The structure of the Jura, the plateau, and the Alps will be studied under the direction of Dr. H. Schardt, the programme being divided into two sections, one before, one after, the Congress. A botanical excursion, under the direction of Dr. C. Schroeter, the well-known authority on the flora of the Alps, will occupy eleven days, from July 15 to 25. The rest will all take place after the Congress, and will mostly be of somewhat shorter duration. A study of vegetation contrasts and the technique of botanical distribution will be undertaken under the guidance of Dr. J. Briquet, and one of glacial morphology under the guidance of Prof. Brückner. Prof. J. Brunhes and others will direct attention to the contrasts between fluvial and glacial erosion, this excursion lasting from August 7 to 14; while Prof. Schardt will explain the structure of the southern portion of the crystalline Alps, between August 7 and 10. Lastly, between the same dates, a party under the guidance of Prof. E. Chaix will study the phenomena of chemical erosion, especially as displayed in the surface forms known as *lapiés*, or *Karrenfelder*, and in the Karst. Practical hints as to equipment are given, and the importance of suitable provision for the high mountain trips is insisted on. The place of meeting is particularly favourable for the arrangement of instructive excursions, and these may be expected to be one of the most prominent and valuable features of the Congress.

The Frobishers of Halifax.—Mr. H. Ling Roth's 'Yorkshire Coiners,' etc. (Halifax, 1906), includes (chap. viii.) an interesting account, illustrated by two portraits, of a doughty Frobisher family of Halifax, with data bearing on the questions of its relationship to the great Elizabethan navigator. Mr. Roth has followed up this account by two communications to the *Halifax Courier*, April 13 and 20 last, the particulars of which are drawn from the Canadian archives, Baine's edition of Alex. Henry's travels, and Masson's 'Bourgeois de la Cie. du Nord-ouest.' In his 'Voyages from Montreal . . . in 1789 and 1793,' Alex. Mackenzie, commemorated in the Mackenzie river, testifies to the hardihood with which Joseph Frobisher "braved every kind of hardship" and penetrated to 55° 25′ N. and 103¼° W.; and how, later on, his brother Benjamin penetrated further west still, as far as 55° 26′ N. and 108° W. The journal, again, of the two fur-trading Alexander Henrys relates that in September, 1775, Joseph and his brother Thomas overtook him (Henry) westward of Lake Winnipeg. From Cumberland House (where, on his fatal expedition, Sir John Franklin erected a still standing sundial) Henry and the Frobishers pushed on to Beaver lake. In all, a party of forty-three, they there built a quadrangle of houses, and, in spite of a temperature 32° below zero, did some very successful fishing. Tiring of the monotony, Henry, on January 1

1776, left Beaver lake for the plains, Joseph convoying him 120 miles to Cumberland House—"a rare feat of friendship, considering the climate." Returning next April, Henry set out with Joseph Frobisher to the Churchill river. Arriving there June 15, they, together with Thomas Frobisher, made their way 450 miles farther west to the country of Lake Arabuthcow. Thence Thomas departed to the Indians' country, while Henry and Joseph proceeded to Montreal, finding it (October 15) under the protection of General Burgoyne. Joseph and Benjamin prospered in trade, became magistrates, and lived in hospitable affluence. On a visit of one of George III.'s sons to Canada, Joseph entertained him as his guest at Montreal. A foremost partner in 1819 of the North-West Company, of which Joseph and Thomas Frobisher were chief founders, was Benjamin, a son or nephew of Joseph. Taking part in a scuffle at Grand Rapid portage between the Hudson bay and North-West Companies in June, 1819, Benjamin received a blow ultimately causing his death. The connection of these Frobishers with the Elizabethan navigator is not conclusively established. The family is traced back to the birth, in 1684, of Benjamin, father of Joseph Frobisher, the father of the above-mentioned fur-traders, and of William and Nathanael. Dr. J. Martin Frobisher, grandson of William, and now residing in Leeds, possesses the coat-of-arms which his father told him had been presented by Queen Elizabeth to Sir Martin, and since handed down from generation to generation. The Frobishers of this narrative came (it is gathered) from Normanton, also the birth-place of the Elizabethan navigator.

CORRESPONDENCE.

Dr. Otto Pettersson on the Influence of Ice-melting on Oceanic Circulation.*

A GREAT part of this paper is occupied by a description of the physical and chemical condition of sea-water, which seems more appropriate to the Chemical Society than to the Royal Geographical Society.

Certain statements are, however, made, and theoretical conclusions drawn from those statements, and I propose to remark on these, and to show how far the theoretical conclusions agree, or disagree, with the ascertained facts.

It is stated on page 281 that "The Russian section of the International Investigation of the sea has discovered a bottom current along the coast bank of Novaya Zemlya, the salinity of which (35 per mille.) equals that of the Gulf Stream water in the Norwegian sea, and whose temperature is about 1°·7 or more below zero. This is the coldest and saltest water known to exist on the globe."

Dr. Pettersson seems to be unaware that Sir John Ross, in 1818, in lat. 72° 23′ N., long. 73°·7′ W., obtained a bottom temperature of −3°·6 C. On this occasion the thermometers were lowered successively to depths of 500, 600, 700, 800, and 1000 fathoms, and the temperatures obtained decreased as the depth increased.

In the same year, in lat. 66° 50′ N., long. 60° 30′ W., the temperature at a depth of 100 fathoms was −0°·9 C., at 200 fathoms −1°·7 C., at 400 fathoms −2°·2 C., and at 660 fathoms −3°·6. Farther south, on October 4, 1818, in lat. 61° 41′ N., long. 62° 16′ W., the temperature at 950 fathoms was +2°·0 C., whilst at the surface it was +4° C., the temperature of the air being +2°·7 C. The above observations were checked by Sir Edward Sabine, who accompanied Sir J. Ross on this expedition.

From conclusions drawn during the voyage of H.M.S. *Challenger*, it is evident that the results obtained in the first two observations in Baffin bay show that that

* See page 273.

area is separated by a submarine ridge from the position of the last observation eastward of Hudson strait, as also from the Atlantic.

It is stated on page 286 that the Atlantic is hydrographically an unknown sea —"a *mare incognitum*."

I cannot understand what Dr. Pettersson means by this, for the Atlantic is fairly well sounded, its deeps and ridges can be drawn with some degree of confidence, and its temperatures from the surface downwards have been ascertained in many positions. Nor has the chemical condition of its waters been neglected, as will be seen by referring to the report on the Physics and Chemistry of the *Challenger* Expedition, by Prof. W. Dittmar, F.R.S.S., of London and Edinburgh.

Dr. Pettersson experiments with pieces of ice in a small receptacle, and from the results thus obtained evolves a theory of oceanic circulation. There does not appear to be anything new in such experiments, which are much the same as those made by the late Dr. W. B. Carpenter in 1869 and 1870, after the first oceanic investigations carried out in H.M. ships *Lightning* and *Porcupine*.

Dr. Pettersson states (p. 283) that the ice-melting experiments show how a cold current is set up on the surface when ice melts, and how cold and salt bottom water is formed, which flows on until stopped by some hindrance, and then builds up into a wall of cold water against this hindrance. Also (p. 284) that in the Atlantic the ice-melting takes place in the Arctic as well as the Antarctic Regions, and thus, in this sea, cold bottom currents from both hemispheres meet below the equator.

If this theory agreed with the facts, we should expect the bottom water in the Atlantic to be of the same temperature from the Arctic to the Antarctic Regions, or, if any change occurred, as the currents flowed at the bottom towards their meeting-place at the equator, the temperature might possibly show a slight gradual increase. But this does not agree with the facts as ascertained from actual observation, for it is found that the bottom temperatures of the Atlantic differ in different areas. In the Arctic part of the Atlantic the bottom temperature is 1° C., or upwards, below zero; in the Antarctic part of the Atlantic the bottom temperature is about the same as in the Arctic; in the eastern part of the Atlantic the bottom temperature is from 2°·2 C. to 2°·8 C., in depths exceeding 2000 fathoms; whilst in the western part the bottom temperature of the North Atlantic is 2°·2 C., and of the South Atlantic 0°·4 C. to 1°·2 C., in depths exceeding 2000 fathoms; a bottom temperature of 0°·8 C. having been obtained not far from the equator in lat. 1° 45′ S., long. 30° 58′ W., in 1873, at a depth of 2475 fathoms. These differences are not gradual, but abrupt, when the depths are equal, for bottom temperatures at equal depths have been recorded as differing 5°·6 C. in a distance of 16 miles; thus in lat. 60° 31′ N., long. 8° 14′ W., the depth being 420 fathoms, the bottom temperature was found to be 0°·1 C., whilst in lat. 60° 17′ N., long. 8° 32′ W., the depth being 423 fathoms, the bottom temperature was found to be 5°·5 C.

Moreover, in the North Pacific ocean there is a fairly uniform bottom temperature of 1°·7 C. at depths exceeding 2000 fathoms, and as this ocean is shut off from the Arctic by Bering strait, it certainly proves that its low bottom temperatures are derived from the Antarctic Regions, and as in no part of the North Atlantic do there appear to be bottom temperatures within 0°·5 C. as low as in the North Pacific, it is justifiable to conclude that the cold water at the bottom in the Atlantic is derived from Antarctic sources alone; and this is further confirmed by the fact that its temperature shows a slight, though very slight, increase as its distance from the Antarctic Regions increases—that is, when the depth exceeds 2000 fathoms.

It therefore appears that Dr. Pettersson's contention that the Atlantic bottom water is derived from Arctic as well as Antarctic Regions cannot be maintained.

In a preceding paragraph it has been shown that different areas in the Atlantic

show differences in the bottom temperature at equal depths. This was apparent very early, when oceanography first began to be systematically studied in 1869–70, for the results of the temperatures obtained in the *Lightning* and *Porcupine* revealed this fact. The reason why such different results were obtained, in adjacent areas at equal depths, was not understood until the more extended investigations of the *Challenger* in 1872–76 were undertaken. During that voyage it was found that the bottom temperatures of certain seas remained constant below a certain depth, thus—

The western part of the Mediterranean has a constant temperature of	12·8° C.	below depths of	100	fathoms.
The eastern ditto ditto	13°·5	„	„	100	„
„ Red sea has a constant temperature of	22°·0	„	„	100	„
„ Sulu sea „ „ „	10°·3	„	„	400	„
„ Celebes sea „ „ „	3°·7	„	„	800	„
„ Banda sea „ „ „	3°·3	„	„	900	„
„ China sea „ „ „	2°·8	„	„	800	„

As there was no question that both the Mediterranean and Red seas were separated from their adjacent oceans by submarine ridges, it appeared almost certain that submarine ridges must separate the other above-named seas from their adjacent oceans, and I ventured to predict, at the meeting of the British Association at Glasgow in 1876, that a submarine ridge must separate the cold water at the bottom of the Arctic basin from the Atlantic, although no indication of such a ridge had been then discovered. In 1880, and again in 1882, a complete exploration of the area between the Scottish coast and the Færoe islands was undertaken, and the submarine elevation discovered which now bears the name of Wyville Thomson ridge. This was sufficient to prove that submarine ridges must exist between adjoining areas whose bottom temperatures at equal depths differed materially, and showed how the cold bottom water of the Arctic basin was prevented from flowing into the Atlantic. Moreover, the temperature observations taken then, and subsequently, show that not only are the temperatures at the bottom constant, but that there is reason to believe that all temperatures below depths of 100 fathoms remain fairly constant, as shown in the table on the following page.

It is not, then, correct to say that cold bottom water flows on until stopped by some hindrance, and then builds up into a wall of cold water against that hindrance; but rather that when areas are separated into basins by submarine ridges, the bottom temperature in each area, cut off from the general circulation, depends partly on the height of the ridge, and partly on the mean minimum temperature of the surface over the area in question.

On p. 285 of Dr. Pettersson's paper it is stated "that in the Atlantic not only do the cold bottom currents meet in the equatorial region, but they are formed there into a mountain of cold bottom water, and that we find here an explanation of the remarkable fact that in one of the Earth's warmest localities, the Guinea gulf, where the surface temperature is 28° C., there is a temperature of 4° to 5° C. at some 100 metres below the surface. *This is probably an effect of the updrift occasioned by the ice-melting in the polar seas.*"

In the table of temperatures given below, it will be seen that at a depth of 200 fathoms the temperatures differ but slightly in positions in 60° N. lat. and in 3° N. lat., which does not look as if there was much updrift. I quite admit that the cold water at the bottom of the ocean, which is open to an area on which there is ice, will derive its low temperature from the being in constant contact with the ice, no matter whether the ice melts or not; and it is certain that if the ocean water was fresh instead of salt, the whole of the ocean, excepting a small depth below the surface, which would be affected by the radiant heat from the sun, would be at

a temperature of about 4° C., the point of maximum density of fresh water. From observation, it does not appear that the sun's heat has much effect at depths exceeding 100 fathoms; therefore, if the ocean was filled with fresh water, its temperature would probably decrease gradually to a depth of 100 fathoms, and then remain constant at a temperature of 4° C. There is no reason to believe that direct radiation from the sun has any more effect on salt water than on fresh, and therefore there seems to be no particular reason for accounting why temperatures of 4° C. should be found at depths of 100 fathoms; the point is, why do temperatures which greatly exceed 4° C. extend to depths in some cases over 1000 fathoms below the surface?

TABLE SHOWING THE TEMPERATURE, IN CENTIGRADE, FROM SURFACE DOWNWARDS, OBTAINED IN OR NEAR THE SAME POSITIONS IN DIFFERENT YEARS.

Depth in fathoms.	Position. Lat. 60° 25′ N., long. 8° 40′ W.		Position. Lat. 60° 2′ N., long. 7° 4′ W.			Position. Lat. 60° 2′ N., long. 5° 48′ W.		Position. Lat. 5° 48′ N., long. 14° 20′ W.			Position. Lat. 3° 9′ N., long. 14° 50′ W.	
	Porcupine, 1869.	*Triton*, 1882.	*Knight Errant*, 1880.	*Triton*, 1882.	*Research*, 1896.	*Knight Errant*, 1880.	*Research*, 1896.	*Challenger*, 1873.	*Waterwitch*, 1894.	*Buccaneer.*	*Challenger*, 1873.	*Challenger*, 1876.
	°	°	°	°	°	°	°	°	°	°	°	°
0	11·8	12·8	12·5	12·8	12·5	12·2	12·2	26·2	26·7	29·7	25·5	28·9
10	—	—	12·3	12·2	12·3	12·2	11·8	—	25·5	28·0	25·8	28·9
20	—	—	12·1	11·7	12·1	11·0	11·2	22·5	24·0	26·4	24·5	27·9
30	—	—	11·7	11·0	11·6	10·3	10·3	—	20·7	18·8	23·0	21·5
40	—	—	9·9	10·8	10·4	10·0	10·0	—	17·1	16·0	21·4	16·8
50	9·2	11·1	9·5	9·5	—	9·6	9·9	16·9	15·66	14·9	19·9	15·3
60	—	—	9·4	—	9·5	9·4	9·7	—	—	—	18·3	14·5
70	—	—	9·2	—	9·2	9·3	9·5	—	—	—	—	—
80	—	—	9·1	—	9·2	9·2	9·2	—	—	—	—	—
90	—	—	9·0	—	9·1	9·0	9·1	—	—	—	—	—
100	8·4	9·5	9·0	9·2	9·1	8·9	8·9	13·4	13·9	13·4	13·9	13·4
120	—	—	8·9	—	9·2	8·7	8·5	—	—	—	—	—
140	—	—	8·8	—	8·8	8·7	8·9	—	—	—	—	—
160	8·0	9·5	8·8	9·2	8·9	8·5	8·8	11·1	11·4	—	—	—
180	—	—	8·7	8·8	8·6	8·4	8·4	—	—	—	—	—
200	7·5	9·5	8·0	8·5	8·8	8·2	8·2	9·0	—	9·4	8·2	9·5
220	—	—	8·0	8·8	8·8	7·5	—	—	—	—	—	—
240	—	—	8·0	8·4	8·8	6·8	6·7	—	—	—	—	—
260	3·5	7·4	8·0	8·3	8·7	4·4	4·5	—	—	—	—	—
280	—	—	—	—	—	2·2	1·7	—	—	—	—	—
300	−0·6	0·2	—	—	—	1·4	1·8	6·3	—	—	5·4	6·5
350	—	—	—	—	—	0·5	0·5	—	—	—	—	—
400	−0·8	−1·0	—	—	—	−0·3	−0·2	4·9	—	—	4·8	5·1
450	—	—	—	—	—	−0·5	−0·3	—	—	—	1·0	—
500	—	—	—	—	—	−0·5	−0·6	4·3	—	—	4·4	4·6
600	—	—	—	—	—	−0·6	−0·6	4·2	—	—	4·1	4·4
700	—	—	—	—	—	—	—	4·1	—	—	3·9	4·3
800	—	—	—	—	—	—	—	4·1	—	—	3·7	4·2

There is no doubt that this is owing to the ocean being composed of salt water, and not fresh. Salt water, like fresh, expands with temperature, but when it is evaporated the salt remains and makes it heavier than the water beneath; consequently it sinks and carries down its heat with it. A good illustration of this is found in the last two columns of the Table of Temperatures of Sea-waters in different years. It will be seen that in 1873, when the surface temperature was 25°·5, the temperatures below the surface decreased more gradually to a depth of 100 fathoms than in 1876, when the surface temperature was 28°·9 C.—4½° higher.

The temperature of the upper water, being much lighter in the latter case, descended more slowly. In the first place, its specific gravity was 1·02324 at its temperature of 25°·5 C.; in the second, its specific gravity was 1·02210 at its temperature of 28°·9 C. At a temperature of 15°·56 C. the specific gravity would be, for the first, 1·02589, and for the second, 1·02578.

It is this sinking of the warm water which heats the water in the eastern part of the North Atlantic, raising its temperature to 4° C. at depths of over 1000 fathoms, and this water is probably derived from the outflow of Mediterranean water, over the ridge separating that sea from the Atlantic, rather than from the Gulf Stream; for Mediterranean water has a much higher specific gravity than Atlantic water, and would consequently sink when it got into the Atlantic, and convey its temperature to considerable depths. At any rate, it is only here that comparatively high temperatures exist at depths of 1000 fathoms, and it is only here that a large basin exists which discharges heated water of a higher specific gravity than that in the basin which receives it. The Japan Stream in the Pacific is similar to the Gulf Stream of the Atlantic, yet the Pacific does not show temperatures of 4° C. anywhere below depths of 700 fathoms.

So far as cold temperatures in the equatorial zone are concerned, I would draw attention to the fact that these cold temperatures are near the land off which the wind blows. The most typical instance is the west coast of South America. Here, at Callao in 12° S. lat., the surface temperature is 15°·5 C., which is the coldest surface temperature in such a low latitude in the world, and there can be little doubt that this is due to the wind blowing away the surface water and causing the water immediately beneath to rise up and supply its place, but not the water from the bottom.

Dr. Pettersson considers that the so-called cold wall between the Gulf Stream and the coast of North America is also due to a rise of the bottom water; but I would point out that the surface temperature of this cold wall rises in August to over 21° C. off New York, and to over 16° C. off the coast of Nova Scotia. It is at that time warmer than the surface water round the British Islands, although there are icebergs on the Newfoundland banks, and the surface temperature there may fall to 9° C. or under.

I think the fact that a large number of cold rivers are discharging into the space between the Gulf Stream and the coast of North America in the winter and spring has been overlooked. The rivers bring down large quantities of cold fresh water and fresh-water ice, which cannot get past the northern edge of the Gulf Stream, and which, being lighter than the ocean water, remains on the surface, and makes the so-called cold wall between the Gulf Stream and the shore. After the snows have melted and the spring freshets from the rivers are over, the surface water quickly becomes warm, and remains warm until the prevailing cold winds of autumn and winter set in, when the contrast between its temperature and that of the Gulf Stream again becomes most marked. But even in November the surface water off New York is about the same temperature as that on the west coast of the British Islands, although one is supposed to be cold, owing, it is said, to the Labrador Current, and the other warm, owing to the Gulf Stream. In my opinion, neither the Labrador Current nor this uprising of the bottom water causes this phenomenon, but simply the rivers of cold and often frozen water discharging into this area from the Chesapeake northward to the St. Lawrence.

In the *Challenger's* voyage the specific gravity of the water was 1·025 at a temperature of 15°·56 C. against 1·027 to the eastward of the Gulf Stream and 1·0267 in the Gulf Stream itself.

In conclusion, I would observe that it is impossible to evolve a theory of oceanic

circulation from one factor alone of the many factors which influence that circulation. To take into consideration the effect only of salt-water ice, and ignore fresh-water ice; the discharge of heated water of a high specific gravity from the Mediterranean basin 2000 miles in length; the effect of wind, which is sufficient to cause a variation in the level of the Baltic sea, at Kronstadt, of 13 feet; and almost as much in the river Plate; and the effect produced by barometric pressure, and the surface currents—is not the method to judge of the resultant force, which is due, more or less, to all these factors, and therefore I do not think Dr. Pettersson's conclusions can be accepted, although he certainly adds to our knowledge by the investigations he has undertaken.

T. H. Tizard.

GEOGRAPHICAL LITERATURE OF THE MONTH.

Additions to the Library.

By EDWARD HEAWOOD, M.A., *Librarian*, R.G.S.

The following abbreviations of nouns and the adjectives derived from them are employed to indicate the source of articles from other publications. Geographical names are as a rule written in full:—

A. = Academy, Academie, Akademie.
Abh. = Abhandlungen.
Ann. = Annals, Annales, Annalen.
B = Bulletin, Bollettino, Boletim.
Col. = Colonies.
Com. = Commerce.
C.R. = Comptes Rendes.
E. = Erdkunde.
G. = Geography, Géographie, Geografia.
Ges. = Gesellschaft.
I. = Institute, Institution.
Iz. = Izvestiya.
J. = Journal.
Jb. = Jahrbuch.
k.k. = kaiserlich und königlich.
M. = Mitteilungen.
Mag. = Magazine.
Mem. (Mém.) = Memoirs, Mémoires.
Met. (mét.) = Meteorological.
P. = Proceedings.
R. = Royal.
Rev. (Riv.) = Review, Revue, Rivista.
S. = Society, Société, Selskab.
Sc. = Science(s).
Sitzb. = Sitzungsbericht.
T. = Transactions.
Ts. = Tijdschrift, Tidskrift.
V. = Verein.
Verh. = Verhandlungen.
W. = Wissenschaft, and compounds.
Z. = Zeitschrift.
Zap. = Zapiski.

On account of the ambiguity of the words *octavo*, *quarto*, etc., the size of books in the list below is denoted by the length and breadth of the cover in inches to the nearest half-inch. The size of the *Journal* is 10 × 6½.

A selection of the works in this list will be noticed elsewhere in the "Journal."

EUROPE.

Alps—Eastern. *Naturw. Wochenschrift* **21** (1906): 801–808, 817–822. **Grüss.**
Naturbetrachtungen im bayrisch-tirolischen Hochgebirge. Von J. Grüss. *With Illustrations.*

Alps—Glaciers. *Riv. G. Italiana* **13** (1906): 453–467. **Toniolo.**
Riscontri su recenti oscillazioni dei ghiacciai dei gruppi Sorapiss e Cristallo nelle Alpi Cadorine (Autunno 1905) eseguiti dal Dott. Antonio Renati Toniolo. *With Maps and Illustrations.*

Alps—Historical. **Coolidge.**
Some early visits to Zermatt and Saas. By W. A. B. Coolidge. (Reprinted from the *Alpine Journal*, November, 1906, and February, 1907.) 'London, 1907. Size 8½ × 5½, pp. 34.

Austria—Anthropogeography. **Firbas.**
Forschungen deuts. Landes- u. Volksk. **16** (1906): 461–556.
Anthropogeographische Probleme aus dem Viertel Unterm Manhartsberge in Niederösterreich. Von Dr. Oskar Firbas. *With Maps and Diagrams.*

See note at p. 331, *ante*.

Austria—Bohemia. **Schneider.**

Ueber die Entwickelung des Kartenbildes von Böhmen. Ein Beitrag zur Geschichte der Geographie dieses Landes. Von Dr. Karl Schneider. Size 9 × 6, pp. 50. *Facsimile Maps.*

Carpathians. *B.S.G. Română* **27** (1906): 143–167. **Martonne**

Notice explicative des reliefs du Paringu et de Soarbele (Karpathes méridionales). Par E. de Martonne. *With Relief maps.*

English Channel—Tunnel. ——

Nineteenth Century **61** (1907): 173–194; *and Supplement*, pp. 136.

The revived Channel tunnel project. [By various writers.]

Europe. **Hettner.**

Grundzüge der Länderkunde. Von Dr. Alfred Hettner. I. Band: Europa. Leipzig: Otto Spamer, 1907. Size 9 × 6, pp. xvi. and 738. *Maps. Price* 16m. *Presented by the Publisher.* [See review, *ante*, p. 320.]

United Kingdom—Hydrology. **Baldwin-Wiseman.**

Quart. J. Geol. S. **63** (1907): 80–105.

The influence of pressure and porosity on the motion of sub-surface water. By W. R. Baldwin-Wiseman. *With Maps and Diagrams.*

United Kingdom—Ireland. *Geological Mag.*, Dec. v. **4** (1907): 17–20. **Reed.**

Notes on some coastal features in Co. Waterford. I. Fornaght Strand. By F. R. Cowper Reed.

United Kingdom—London. *B.G.S. Philadelphia* **5** (1907): 15–29. **Johnson.**

A study of London: an essay in human geography. By Emory R. Johnson.

United Kingdom—Scotland. *T.R.S. Edinburgh* **45** (1907): 407–490. **Wedderburn.**

The temperature of the fresh-water lochs of Scotland, with special reference to Loch Ness. With appendix containing observations made in Loch Ness by members of the Scottish Lake Survey. By E. M. Wedderburn. *With Diagrams.*

Western Europe—Meuse. *B.S. Belge G.* **20** (1906): *Procès-Verbaux*, 171–178. **Pohlig.**

Une ancienne embouchure de la Meuse, près de Bonn. Par H. Pohlig.

ASIA.

Central Asia. **Futterer.**

Durch Asien. Erfahrungen, Forschungen und Sammlungen während der von Amtmann Dr. Holderer unternommenen Reise. . . . Von Dr. K. Futterer, fortgesetzt von Dr. Fritz Noetling. Band ii. Geologische Charakter-Bilder. Erster Teil. Berlin: D. Reimer, 1905. Size 11 × 7½, pp. xvi. and 394. *Maps and Illustrations. Price* 20m. *Presented by the Publisher.* [To be reviewed.]

Central Asia. **Obrucheff.**

Expedition to the Barlik and Tarbagatai in 1905. Preliminary Report. By V. A. Obrucheff. Tomsk, 1907. Size 10½ × 6½, pp. 22. [In Russian.] *Presented by the Author.*

See note in the *Journal* for August, 1906 (p. 180).

Central Asia—Transport. *G. Ts.* **19** (1907–8): 18–32. **Olufsen.**

Samfaerdsels- og Transportmidler i Indre-Asien. Af Ole Olufsen. *With Illustr.*

China—Kiangsi. *Z. Ges. E. Berlin*, 1907: 177–182. **Wegener.**

Ueber seine Reise durch die Provinz Kiangsi. Von Dr. Georg Wegener.

See note in the August number, p. 211.

China—Kwang-si. *B.S.G. Lyon* **21** (1906): 169–205. **François.**

En mission au Kouang-si. Par le Lieut. G. François.

Gives a general sketch of the province, and discusses the French relations with it.

Chinese Turkestan. *B. American G.S.* **39** (1907): 65–77, 137–146. **Huntington.**

Lop-Nor—a Chinese lake. By Ellsworth Huntington. *With Map.*

See note in the June number, p. 674.

Chinese Turkestan and Tibet. *Globus* **91** (1907): 133–138. **Zugmayer.**

Eine Reise durch Ostturkestan und Westtibet. Von Dr. Erich Zugmayer. *With Illustrations.*

Dutch East Indies—Sumatra. **Daalen.**
Ts. K. Nederland. Aardrijksk. Genoots. **24** (1907): 204–212.
Nota over het Alas-land. Door G. C. E. van Daalen.

India—Burma. **Wehrli.**
Zur Wirtschafts- und Siedlungs-Geographie von Ober-Burma und den Nördlichen Shan-Staaten. Von Dr. Hans J. Wehrli. (Separatabdruck aus Wissenschaftliche Beilage zum Jahresbericht der Geogr.-Ethnogr. Gesellschaft, 1905–6.) Zürich, 1906. Size 9 × 6, pp. 130. *Maps and Illustrations. Presented by the Author.*

AFRICA.

Abyssinia. *B.S.G. Italiana* **8** (1907): 323–330. **Castro.**
Un convento trogloditico ad Eccà presso Addis-Abeba. Del Dott. Lincoln de Castro. *With Illustrations.*
On a grotto, partly at least artificial, which seems to date from the early Portuguese period.

Africa—Volcanoes. *Münchener G. Studien* **18** (1906): pp. ii. and 218. **Simmer.**
Der aktive Vulkanismus auf dem afrikanischen Festlande und den afrikanischen Inseln. Von Hans Simmer.

British East Africa. ——
East Africa Protectorate. Report for 1905–6 (Colonial Reports, Annual No. 519, 1907). Size 9½ × 6, pp. 138. *Price 7d.*

British East Africa. ——
Handbook for East Africa, Uganda, and Zanzibar, 1907. Mombasa, [*not dated*]. Size 7½ × 5, pp. 300 and iv. *Map. Price 2s. Presented by the Editor.*

Canaries—Climatology. *Meteorologische Z.* **24** (1907): 64–74. **Burchard.**
Ein Beitrag zur Klimatologie der Kanarischen Inseln. Von Dr. Oscar Burchard. *With Diagram.*

Cape Colony—Orography. *B. American G.S.* **38** (1906): 593–623. **Davis.**
The mountains of southernmost Africa. By W. M. Davis. *With Map and Illustrations.*

Congo State. *B.S.R.G. Anvers* **30** (1906): 5–26. ——
Manifestation en l'honneur des Explorateurs belges au Congo, 20 Janvier, 1906.
This paper is followed by sketches, supplied by distinguished explorers, of the course of discovery in different parts of the Congo basin, and also by biographical notices of the principal travellers.

Congo State—Ethnology. **Halkin.**
Prof. Joseph Halkin. Quelques peuplades du district de l'Uelé (État Indépendant du Congo). Monographies ethnographiques. Fascicule I. Introduction. Les Ababua. Liége, 1907. Size 10 × 6½, pp. 156. *Map and Illustrations. Presented by the Author.*

Congo State—Railway. *Mouvement G.* **24** (1907): 97–101. **Wauters.**
Le Chemin de fer des Stanley Falls. Par A.-J. Wauters. *With Map and Portrait.*
The portrait is of M. Adam, the chief engineer.

Congo State—Railways. *Mouvement G.* **24** (1907): 133–137. **Goffin.**
Le chemins de fer du Congo. Par L. Goffin. *With Sketch-map.*

Congo State—Railways. *B.S.R.G. Anvers* **30** (1906): 114–126. **Thys.**
Les chemins de fer au Congo. Par le Colonel Thys.

Egypt—Fayum. *Survey Notes* (Cairo) **1** (1906): 10–15. ——
The Salinity of Birket-el-Qurun. By A. L.

Egypt—Public Works. **Garstin.**
Report upon the administration of the Public Works Department in Egypt for 1905. By Sir William Garstin. Cairo, 1906. Size 11 × 7½, pp. 356. *Illustrations and Diagrams.*

French Congo. *Quest. Diplomatiques* **22** (1906): 713–731. **Cambier.**
Le Congo français. Ses ressources, son avenir, ses projets. Par Lucien Cambier. *With Maps and Diagrams.*
The author was at the head of the recent railway survey (see vol. **29**, p. 347).

German East Africa. *Ymer* 1906: 363–382. **Sjöstedt.**
Kilimandjaro-expeditionens allmänna gång och resultat. Af Yngoe Sjöstedt. *With Illustrations.*
On the Swedish expedition of 1905.

German East Africa. *M. deuts. Schutzgebieten* 19 (1906): 294–304. **Weule and Jäger.**
Bericht über die landeskundlichen Expeditionen des Herren Prof. Dr. Karl Weule und Dr. Fritz Jäger in Deutsch-Ostafrika.
See note in the February number (p. 226) and April (p. 457).

German South-West Africa. *M. a.d. Deuts. Schutzgebieten* 20 (1907): 1–84. **Ottweiler.**
Die Niederschlags-Verhältnisse von Deutsch-Südwestafrika. Von Dr. Emil Ottweiler. *With Maps and Diagrams.*

German South-West Africa. *Deutsches Kolonialblatt* 18 (1907): 33–34. ——
Das Minengebiet von Tsumeb.

Gold Coast—Ethnology. **Vortisch.**
Globus 89 (1906): 277–283, 293–297; 90 (1906): 232–237, 249–253.
Die Neger der Goldküste. Von Dr. H. Vortisch. *With Illustrations.*

Kamerun. *Globus* 91 (1907): 1–6, 26–32, 44–47. **Hutter.**
Bamum. Von Hauptmann a. D. Hutter. *With Illustrations.*

Morocco. ——
Treaty Series, No. 4, 1907. General act of the International Conference at Algeciras relating to the affairs of Morocco. April 7, 1906. London, 1907. Size 9½ × 6, pp. 78. *Price* 4*d.*

Morocco—Atlas. *C.R.A. Sc., Paris* 144 (1907): 105–107. **Kilian and Gentil.**
Sur l'Aptien, le Gault et le Cénomanien et sur les caractères généraux du Crétace inférieur et moyen de l'Atlas occidental marocain. Note de W. Kilian et Louis Gentil.

Niger—Historical. *Scottish G. Mag.* 23 (1907): 58–72. **Johnston.**
The Niger basin and Mungo Park. By Sir Harry H. Johnston. *With Map.*

Nigeria. **[Egerton.]**
Southern Nigeria (Lagos). Report for 1905 (Colonial Reports, Annual, No. 507.) London, 1906. Size 9½ × 6, pp. 50. *Diagrams. Price* 10*d.*

Nigeria. **[Lugard.]**
Northern Nigeria. Report for 1905–6. (Colonial Reports, Annual, No. 516.) London, 1907. Size 9½ × 6, pp. 130. *Map and Diagram. Price* 1*s.* 2*d.*

Sahara. *Globus* 91 (1907): 65–66. **Kleist.**
Die Oase Bilma. Von Oberleutnant v. Kleist.

South Africa—Harbours. *P.I. Civil Engineers* 166 (1905–06): 4–76. **Methven.**
The Harbours of South Africa; with special reference to the causes and treatment of sand-bars. By Cathcart William Methven. *With Map and Plans.*

South Africa—Kalahari. *Globus* 90 (1906): 299–302. **Passarge.**
Wasserwirtschaftliche Probleme in der Kalahari. Von S. Passarge.

South Africa—Phytogeography. *Sitzungsber. K. preuss. A. W.*, 1906: 866–906. **Engler.**
Beiträge zur Kenntnis der Pflanzenformationen von Transvaal und Rhodesia. Von A. Engler.
Based on personal observations during the visit of the British Association.

South Africa—Zambesi. *B.S.G. Lisboa* 24 (1906): 297–318, 344–353. **Bivar.**
Curso medio do Zambeze. (Extractos d'um relatorio.) Por Hugo Stauffengar Bivar.

South Africa—Zambesi. *J. Anthropological I.* 36 (1906): 159–169. **Lamplugh.**
Notes on the occurrence of stone implements in the valley of the Zambesi around Victoria Falls. By G. W. Lamplugh. *With Maps and Illustrations.*

Transvaal—Coal. **Mellor.**
Transvaal Mines Department: Geological Survey, Memoir No. 3. The geology of Transvaal Coal-measures, with special reference to the Whitbank Coal-field. By E. T. Mellor. Pretoria, 1906. Size 9½ × 6, pp. 60. *Map, Sections, and Illustrations.*

Tripoli—Commercial. *Österr. Monatsschrift f.d. Orient.* **33** (1907): 1–4. ——

Wirtschaftliche Verhältnisse in Tripolitanien.

West Africa—Boundary. *Globus* **90** (1906): 284–286. **Moisel.**

Aufgaben und Resultate der Südkamerun-Grenzexpedition, 1900–1902. Von M. Moisel. *With Map.*

West Africa—Boundary. ——

Treaty Series, No. 17, 1906. Agreement between the United Kingdom and Germany respecting the boundary between British and German territories from Yola to Lake Chad. Signed at London, March 19, 1906. London, 1906. Size 9½ × 6, pp. 10. *Maps. Price* 1*s.* 10*d.*

See map in the April number, p. 459.

NORTH AMERICA.

Alaska. *B.G.S. Italiana*, IV. **8** (1907): 12–29, 181–200. **Almagia.**

Le presenti condizioni naturali ed economiche dell' Alasca. Del dott Roberto Almagia. *With Map.*

Alaska. *B.U.S. Geol. Surv.* **299** (1906): pp. 690. **Baker and McCormick**

Geographic Dictionary of Alaska. By Marcus Baker. 2nd edition. Prepared by James McCormick.

Alaska. *B.U.S. Geol. Surv.* **295** (1906): pp. 28. **Prindle.**

The Yukon-Tanana Region, Alaska. Description of Circle quadrangle. By L. M. Prindle. *With Map.*

Alaska—Glacial Erosion. *Popular Sc. Monthly* **70** (1907): 99–119. **Tarr.**

Glacial Erosion in Alaska. By Prof. Ralph S. Tarr. *With Illustrations.*

See note in the May number (p. 592).

Alaska—Glaciers. *American B.G.S.* **39** (1907): 129–136. **Tarr and Martin.**

Position of Hubbard glacier front in 1792 and 1794. By Ralph S. Tarr and Lawrence Martin. *With Map and Illustrations.*

Canada—Fuels. **Ells.**

Notes on the mineral fuel-supply of Canada. By R. W. Ells. (From the *Transactions* of the Royal Society of Canada, Second series, 1906–07, vol. **12**, Section iv.) Ottawa, 1906. Size 10 × 6½, pp. 267–288.

St. Laurence—Niagara Falls. *B.U.S. Geol. Surv.* **306** (1907): pp. 32. **Gilbert.**

Rate of recession of Niagara Falls. By G. K. Gilbert; accompanied by a report on the survey of the crest, by W. Carvel Hall. *With Maps and Illustrations.*

See note in the Monthly Record, *ante*, p. 335.

United States—California. *Popular Sc. Monthly* **70** (1907): 5–18. **Byers.**

The possibilities of Salton Sea. By Charles Alma Byres. *With Map and Illustrations.*

See note in the April number, p. 461.

United States—Colorado. *B.U.S. Geol. Surv.* **291** (1906): pp. 186. **Gannett.**

A Gazetteer of Colorado. By Henry Gannett.

United States—Colorado. *J. Geology* **15** (1907): 15–22. **Siebenthal.**

Notes on glaciation in the Sangre de Cristo range, Colorado. By C. E. Siebenthal. *With Illustrations.*

United States—Commercial. **Dove.**

Die angelsächsischen Riesenreiche. Eine wirtschaftsgeographische Untersuchung. Von Dr. K. Dove. II. Die Vereinigten Staaten von Nordamerika. Jena: H. Costenoble, 1907. Size 9 × 6, pp. iv. and 66. *Price* 2.50*m. Presented by the Publisher.*

United States—Magnetism. **Bauer.**

U.S. Coast and Geodetic Surv., Rep., 1906, Appendix 3: pp. 105–210.

Results of Magnetic Observations made by the Coast and Geodetic Survey between July 1, 1905, and June 30, 1906. By L. A. Bauer. *With Illustration.*

United States—Magnetism. **Bauer.**

U.S. Coast and Geodetic Surv. Rep., 1906, Appendix 4: pp. 211–226.

Distribution of the Magnetic Declination in the United States for January 1, 1905. By L. A. Bauer. *With Map.*

United States—Massachusetts. *Ann. de G.* **15** (1906): 443–448. **Allorge.**
Esquisse géographique du cap Cod (États-Unis). Par Maurice Allorge. *With Sketch-map and Illustrations.*

United States—Mississippi. *Science* **24** (1906): 861–866. **Hilgard.**
The Exceptional Nature and Genesis of the Mississippi delta. By E. W. Hilgard.

United States—Montana. *U.S. Geol. Surv., Prof. Paper* **50** (1906): pp. 62. **Calhoun.**
The Montana lobe of the Keewatin Ice-sheet. By Fred. H. H. Calhoun. *With Maps and Illustrations.*

United States—New Jersey. *J. Geology* **15** (1907): 39–45. **Lewis.**
The Double Crest of Second Watchung mountain. By J. Volney Lewis. *With Maps.*

United States—New Mexico. *J. Franklin I.* **162** (1906): 449–465. **Carter.**
Acoma: the Cliff City of New Mexico. By Prof. Oscar C. S. Carter. *With Illustrations.*

United States—New Mexico. **Fisher.**
U.S. Geol. Surv., Water-supply Paper **158** (1906): pp. 30.
Preliminary Report on the Geology and Underground Waters of the Roswell Artesian area, New Mexico. By Cassius A. Fisher. *With Maps and Illustrations.*

United States—New York. **Gannett and Baldwin.**
B.U.S. Geol. Surv. **281** (1906): pp. 112.
Results of Spirit-levelling in the State of New York for the years 1896 to 1905, inclusive. By S. S. Gannett and D. H. Baldwin.

United States—Pennsylvania. **Gannett and Baldwin.**
B.U.S. Geol. Surv. **288** (1906): pp. 62.
Results of Spirit-levelling in Pennsylvania for the years 1899 to 1905, inclusive. By S. S. Gannett and D. H. Baldwin.

United States—Petroleum. *B.U.S. Geol. Surv.* **282** (1906): pp. 146. **Fenneman.**
Oil Fields of the Texas-Louisiana Gulf Coastal plain. By N. M. Fenneman. *With Maps, Plans, and Illustrations.*

United States—Virginia. *B. American G.S.* **38** (1906): 741–753. **Surface.**
Physiography of Virginia. By G. T. Surface.

CENTRAL AND SOUTH AMERICA.

Argentine—Rio de la Plata. *An. S. Cient. Argentina* **62** (1906): 257–272. **Mercau.**
Canalización artificial del Río de la Plata. Por Agustin Mercau. *With Map.*
Noticed in the Monthly Record (*ante*, p. 336).

Bolivia—Andes. **Peck.**
Climbing Mount Sorata. By Annie S. Peck. (Extracted from *Appalachia*, vol. 11, No. 2.) [Boston, 1906.] Size 9 × 5½, pp. 95–110. *Illustrations. Presented by the Author.*
The writer claims to have reached 20,500 feet, or from 600 to 800 feet below the summit, but the altitude was ascertained by aneroid only.

Brazil. *Rev. I.G. e Hist., Bahia* **12** (1905): 59–91. **Amaral.**
Bahia—Espirito Santo. Limite entre os dous estados. Pelo Dr. Braz do Amaral.

Chile-Argentine Boundary. **Patron.**
Republica de Chile: Oficina de Limites. La linea de frontera en la Puna de Alacama, por Luis Riso Patron S. Segun los trabajos de la Sesta Subcomision Chilena de Limites con la Republica Arjentina ejecuta bajo la direccion del ingeniero don Victor Caro T. Santiago, 1906. Size 11 × 7½, pp. x. and 294. *Maps and Illustrations. Presented.*

Chile—Seismology. **Henríquez.**
Hormidas Henríquez. El terremoto de Valparaiso bajo su aspecto constructivo. (Valparaiso), 1907. Size 6½ × 3, pp. 56.
Discusses the effects of the earthquake on buildings.

Chile—Seismology. **Steffen.**
Informes de la Comision de Estudios del Terremoto del 16 de Agosto de 1906;

Primera parte. Reseña jeneral sobre los elementos sísmicos mas importantes del terremoto. Por el Dr. H. Steffen. Santiago, 1907. Size 10½ × 6½, pp. 68. *Map and Diagrams.*

Columbia—Canal. *B.R.S.G. Madrid* **48** (1906): 540–557. **Zerda.**

Canales interoceánicos de Colombia. Por el Dr. D. B. Novoa Zerda. *With Map.*

Discusses projects for utilizing the Atrato.

Costa Rica and Panama. *B. Bureau American Republics* **24** (1906): 85–90. ———

Boundary Treaties between Costa Rica and Panama.

Ratified by the Congress of Panama on January 25, 1907 (see note in the May number, vol. **29**, p. 572, with map).

Panama Canal. *J.S. Arts* **55** (1907): 239–276. **Bunau-Varilla.**

The Panama canal—the "Lock-Canal" type and the "Straits of Panama" type. By Philippe Bunau-Varilla. *With Maps, Illustrations, and Sections.*

Peru. *B. Cuerpo Ingenieros Minas, Peru* **42** (1906): pp. 128. **Stiles.**

Examen tecnico de las Lagunas de Huarochiri del Departamento de Lima. Por Alberti I. Stiles. *With Map and Illustrations.*

Pilcomayo River. **Lange.**

The River Pilcomayo from its discharge into the River Paraguay to Parallel 22° S. By Gunnar Lange. Buenos Aires, 1906. Size 10½ × 7, pp. 126. *Plan and Illustrations. Also maps, separate,* size 15½ × 10½. *Presented by the Author.* [To be reviewed.]

Tierra del Fuego. **Alboff.**

Anales del Museo de La Plata. Sección botanica. I. Essai de flore raisonnée de la Terre de Feu. Par Nicolas Alboff. La Plata, 1902. Size 14½ × 11, pp. vi., 86, and xxiv. *Portrait.*

West Indies—Curaçao. *Globus* **90** (1906): 293–299. **Krämer.**

Curaçao, nebst einigen Bemerkungen über eine westindische Reise (1899–1900). Von Dr. Augustin Krämer. *With Sketch-map and Illustrations.*

West Indies and South America. *B.S. Belge Géologie* **20** (1906): 83–161. **Van de Wiele.**

La Méditerranée des Antilles et le bassin préandin considérés comme régions d'affaisement. Par le Dr. C. van de Wiele. *With Map.*

AUSTRALASIA AND PACIFIC ISLANDS.

Marianne Islands. *Deutsche Rundschau G.* **29** (1907): 193–206. **Seidel.**

Die Bevölkerung der deutschen Marianen. Von H. Seidel. *With Illustrations.*

New Guinea. *Z. Ges. E. Berlin* (1907): 149–165. **Pöch.**

Ueber meine Reise in Deutsch-, Britisch-, und Niederländisch- Neu-Guinea. Von Dr. Rudolf Pöch. *With Illustrations.*

New Guinea—Dutch. **Hellwig.**

Ts. K. Nederland. Aardrijksk. Genoots. **24** (1907): 200–203.

Toevoegingen tot den onderzoekingstocht naar de Oostbaai (dd. 6–25 Oct., 1906). Door R. L. A. Hellwig.

New Guinea—Dutch. **Hellwig.**

Ts. K. Nederland. Aardrijksk. Genoots. **24** (1907): 213–219.

Een landtocht naar de grens van Britsch Nieuw-Guinea van Mĕraukĕ uit, in Sept. 1906. Door R. L. A. Hellwig.

New Guinea—Dutch. **Herwerden.**

Ts. K. Nederland. Aardrijksk. Genoots. **24** (1907): 178–199.

Beschrijving van eene reis tot nader onderzoek der in de Oostbaai (Z. W. Nieuw-Guinea) uitmondende Oetoemboewe; en eerste onderzoek der "Noord"-rivier aldaar (dd. 6–25 Oct. 1906). Door J. H. Hondius van Herwerden. *With Map and Illustrations.*

POLAR REGIONS.

Antarctic—Bacteria. **Ekelöf.**

Studien über den Bakteriengehalt der Luft und des Erdbodens der antarktischen Gegenden, ausgeführt während der schwedischen Südpolar-Expedition 1901–1904, Von Erik Ekelöf. (Separat-Abdruck a. d. Zeitschrift für Hygiene, etc., lxi. Bd., 1907.) Leipzig, 1907. Size 9 × 6, pp. 344–370.

Antarctic—Expedition. ———

Seconde Expedition Antarctique Belge. Procès-Verbaux des séances préliminaires tenues sous la Présidence de M. le Ministre d'État Beernaert à Bruxelles. Bruxelles, 1907. Size 9½ × 6½, pp. 14.

Arctic—Ice. **Garde.**

The State of the Ice in the Arctic Seas, 1906. Prepared by V. Garde. [Copenhagen, 1907.] Size 12 × 9½, pp. 14. *Charts.*

Arctic—Peary Expedition. **Peary.**

Nearest the North Pole. First complete report of the Peary Arctic Club's latest expedition. By Commander Robert E. Peary. (From *Harper's Monthly Magazine*, London, etc., February and March, 1907.) Size 9½ × 6½, pp. 335–350 and 497–510. *Map and Illustrations.*

Arctic—Peary Expedition. **Peary.**

Nearest the Pole. A Narrative of the Polar Expedition of the Peary Arctic Club in the S.S. *Roosevelt*, 1905–1906. By R. E. Peary. London: Hutchinson & Co., 1907. Size 10½ × 7, pp. xx. and 410. *Maps and Illustrations. Price* 21*s. net. Presented by the Publishers.*

See review, *ante*, p. 326.

MATHEMATICAL GEOGRAPHY.

Altitudes. **Schoen.**

Anleitung für die Manipulationen bei den barometrischen Hohenmessungen, mit besonderer Rücksicht auf Trassierungen von Bahnstrecken, verfasst von Joh. G. Schoen. Leipzig and Wien: F. Deuticke, 1907. Size 9½ × 6, pp. vi. and 18. *Price* 1m. *Presented by the Publisher.*

Cartography. *B.S.G. de l'Est* **27** (1906): 125–159, 301–334. **Helbronner.**

L'histoire des cartes géographiques et procédés actuels de leur établissement en haute montagne. Par Paul Helbronner. *With Map.*

Cartography. ———

Service géographique de l'Armée. Rapport sur les travaux exécutés en 1905. Paris, 1906. Size 10 × 6½, pp. 40. *Index-maps.*

Time Determination. *Riv. G. Italiana* **13** (1906): 468–475, 532–538. **Andreini.**

Quale importanza possa conservare ancor oggi la gnomonica. Del Prof. Dott. Angelo L. Andreini.

PHYSICAL AND BIOLOGICAL GEOGRAPHY.

Climatology. **Gregory.**

Climatic Variations: their Extent and Causes. By J. W. Gregory. Mexico, 1906. Size 11 × 8, pp. 24.

Climatology. **Manson.**

Climats des temps géologiques: leur developpement et leurs causes. Par Marsden Manson. Mexico, 1906. Size 11 × 8, pp. 58. *Diagrams.*

Coral Reefs. *G.Z.* **13** (1907): 24–44, 92–111. **Langenbeck.**

Der gegenwärtige Stand der Korallenrifffrage. Von R. Langenbeck.

Erosion. *J. Geology* **15** (1907): 113–120. **Westgate.**

Abrasion by Glaciers, Rivers, and Waves. By Lewis G. Westgate. *With Illustrations.*

Geological History. **Daly.**

The Limeless Ocean of pre-Cambrian Time. By Reginald A. Daly. (From the *American Journal of Science*, vol. **23**, February, 1907.) Size 9½ × 6, pp. 93–115. *Presented by the Author.*

Puts forward the hypothesis that the unfossiliferous character of pre-Cambrian sediments is due to the absence of lime-salts from the sea-water of that period, owing to their previous precipitation through the decomposition of dead (soft-bodied) organisms. A good deal of assumption is involved.

Meteorology—Atmosphere. *Annalen Hydrographie* **34** (1906): 505–510. **Schweppe.**

Die Erforschung der höheren Schichten der Atmosphäre an Bord S.M.S. *Planet.* Von Oberleutnant Schweppe.

Meteorology—Clouds. *Meteorologische Z.* **23** (1906): 497-504. **Rheden.**
Wolkenhöhenmessungen mit Hilfe der Scheinwerferanlage des neuen Wiener Leuchtbrunnens. Von Dr. Joseph Rheden.
See note in the February number (p. 233).

Oceanography. **Ekman and others.**
Resultaten af den Internationella Hafsforskningens arbete under åren 1902–1906, och Sveriges andel däruti. Sammanfattade af Svenska Hydrografisk-Biologiska Kommissionens verkställande utskott. G. Ekman, O. Pettersson, och F. Trybom. Stockholm, 1907. Size 9 × 6, pp. 164. *Maps and Illustrations.*

Oceanography—Baltic. ——
Annalen Hydrographie **34** (1906): 265–278, 313–325, 374–385.
Oberflächenströmungen im Kattegat, Sund und in der westlichen Ostsee. *With Charts.*

Oceanography—Depths. *B.S.G. Italiana* **6** (1905): 427–444, 502–522. **Almagià.**
Sullo sviluppo delle conoscenze delle profondità marine. Di Roberto Almagià.

Oceanography—North Sea. **Dalhuisen and Ringer.**
Conseil Internat. Explor. Mer.; Publs. de circonst., No. **36** (1907): pp. 16.
Fortgesetzte Strommessungsversuche in der Nordsee. Von A. F. H. Dalhuisen und W. E. Ringer. *With Diagrams.*

Oceanography—Sea-water. *B.I. Océanogr.*, No. **88** (1907): pp. 12. **Allemandet.**
Analyses des échantillons d'eau de mer recueillis pendant la campagne du yacht *Princesse Alice* en 1906. Par G.-H. Allemandet. [In French and Esperanto.]

Seismology. *Science* **24** (1906): 545–551. **Heilprin.**
The concurrence and interrelation of volcanic and seismic phenomena. By Prof. Angelo Heilprin.

Seismology. *Beiträge zur Geophysik.* **8** (1907): 219–292. **Hobbs.**
On some principles of seismic geology. By William Herbert Hobbs. *With Maps and Diagrams.*

ANTHROPOGEOGRAPHY AND HISTORICAL GEOGRAPHY.

Commercial—Communications. *Ann. G.* **15** (1906): 401–418; **16** (1907): 1–14. **Hückel.**
La géographie de la circulation, selon Friedrich Ratzel. Par G.-A. Hückel.

Commercial—Ocean Navigation. *Deutsche Erde* **6** (1907): 15–20. **Baberadt.**
Die Entwickelung der Bremer Seeschiffahrt. (Zur 50-jährigen Gründungsfeier des Norddeutschen Lloyd am 20. Februar 1907.) Von Dr. Karlfriedrich Baberadt. *With Map and Illustrations.*

Commercial—Oil-grasses. *Kew B.* (1906): 297–363. **Stapf.**
The Oil-grasses of India and Ceylon. By Otto Stapf. *With Plate.*

Commercial—River Navigation. *B. American G.S.* **39** (1907): 147–158. **Brown.**
The Movement of Load in Streams of Variable Flow. By Robert Marshall Brown.
Discusses the changes to which river-beds are subject at periods of low water, and the conditions of navigation at such times.

Commercial—Salt. *B.I. Océanographique Monaco*, No. 100 (1907): pp. 44. **Maillard.**
L'industrie des salines côtières. Par le Dr. L. Maillard. *With Maps and Illustrations.*

Disease—Beri-beri. *Philippine J. Sc.* **1** (1906): 709–764. **Herzog.**
Studies in Beriberi. By Maximilian Herzog. *With Illustrations.*

Ethnology—Esquimaux. *Ymer* **37** (1907): 15–48. **Hamberg.**
L'origine des Esquimaux et les premières populations de l'Amérique. Par Axel Hamberg. [In Swedish.]

Historical. *Münchener G. Studien* **19** (1906): pp. 102. **Ebner.**
Geographische Hinweise und Anklänge in Plutarch's Schrift "De facie in orbe lunae." Von Eduard Ebner.

Historical—Alphonse de Saintonge. *B.G. Hist. et Descriptive* (1906): 120–127. **Musset.**
La vérité sur Alfonce de Saintonge. Par Georges Musset.
A reply to M. Pawlowski's article in the same magazine.

BIOGRAPHY.

Pytheas. *Riv. G. Italiana* **13** (1906): 233–241, 297–315, 398–419, 476–484. **Rambaldi.**
Pitèa da Marsiglia. Note di Pier Liberale Rambaldi. *With Sketch-map.*

Kirchhoff. *G. Anzeiger* **8** (1907): 25–27. **Ule.**
Alfred Kirchhoff. Von Prof. Dr. Willi Ule. *With Portrait.*

Santarem. *B.S.G. Lisboa* **25** (1907): 5–24. **Eça.**
A obra scientifica do Visconde de Santarem. Por Vicente Almeida d'Eça.

GENERAL.

British Empire. ———
Published proceedings and précis of the Colonial Conference, 15th to 26th April, 1907. London, 1907. Size 13 × 8½, pp. 28. *Price* 3*d.*

Catalogue. ———
Catalogue of the War Office. Part I. [London, 1906.] Size 10 × 6, pp. 1308. *Presented by the War Office.*

This part consists of an author's catalogue in alphabetical order, in which are also incorporated anonymous works entered under the first word of the title, or sometimes under subjects. The other two parts will consist of a catalogue of official and other series, and a subject catalogue of all works not already so entered.

Education. *Queensland G.J.* **21** (1905–06): 61–70. **Dodge.**
The opportunity of the geographer in promoting school geography. By Richard Elmwood Dodge.

Geography. *Jahresber. Frankfurter V.G.* **70** (1905–06): 133–150. **Günther.**
Die Erdkunde in den letzten zehn Jahren. Festrede . . . gehalten von Prof. Dr. Siegmund Günther.

Geography. *Queensland G.J.* **21** (1905–06): 43–60. **Mill.**
The present problems of geography. By Dr. H. R. Mill.

Read at the anniversary celebration of the R.G.S. of Australasia, Queensland (see *Journal*, vol. **28**, p. 514).

NEW MAPS.

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Part vii.—The Country around Ammanford (Explanation of sheet 230). 2*s.* 6*d.*
Part viii.—The Country around Swansea (Explanation of sheet 247). 2*s.* 6*d.*
(*E. Stanford, London Agent.*)

England—London. **Land Registry Survey Department.**

Diagram of the County of London, showing plans revised by the Land Registry Survey Department, and approximate positions of lithoprints of certain revised areas. 1907. London: Land Registry, 1907. *Presented by Colonel F. P. Washington, R.E., Map Department, Land Registry.*

Italy. **Stefani.**

Geologische Karte der Phlegräischen Felder. Von Carlo de Stefani. Scale 1: 75,000 or 1 inch to 1·2 stat. mile. *Petermanns Mitteilungen*, Erganzungaheft, No. 156. Gotha: Justus Perthes, 1907. *Presented by the Publisher.*

This map has been prepared to illustrate Prof. Dr. Carlo de Stefani's exhaustive article on the geology of the Phlegrean Fields which forms Ergänzungsheft No. 156 of *Petermanns Mitteilungen*, recently published.

ASIA.

Asia Minor. **Schaffer.**

Die Grundzüge der Verbindung Anatoliens und Armeniens. Von F. X. Schaffer. Scale 1: 3,700,000 or 1 inch to 58·4 stat. miles. *Petermanns Mitteilungen*, Jahrgang, 1907, Tafel 12. Gotha: Justus Perthes, 1907. *Presented by the Publisher.*

To illustrate Dr. Franz X. Schaffer's paper "Grundzüge des geologischen Baues von Türkisch-Armenien und dem Ostlichen Anatolien," which appeared in the July number of *Petermanns Mitteilungen* for this year.

Indian Government Surveys. **Surveyor-General of India.**

Indian Atlas, Scale 1 inch to 4 miles. Sheets: 17, parts of districts Mianwali, Multan, Muzaffargarh, Montgomery, Jhang, Lyallpur, Dera Ghazi Khan, and of States Bahawalpur (Punjab) and Bikaner (Rajputana agency), 1904. 107 N.W., parts of districts Ganjam and Vizagapatam (Madras) and Angul (Bengal), and States Patna, Sonpur, Kalahaudi, and Baud (Bengal), 1906.—India and adjacent countries. Scale 1: 1,000,000. Sheet 85, part of Burma, 1906.—Bengal: Bhagalpur District, 1 inch to 1 mile, sheet 2, 1906; Saran District, 1 inch to 8 miles, 1906.—Bengal Survey, 1 inch to 1 mile. Sheets: 36, part of district Palamau, 1902; 63, parts of district Palamau and Hazaribagh, 1903; 143, parts of districts Muzaffarpur and Darbhanga, 1907; 183, parts of districts Manbhum and Hazaribagh, 1906; 209, parts of districts Santhal Parganas, Manbhum, and Burdwan, 1906; 212, parts of districts Manbhum and Bankura, 1906.—Bombay: The Sind Survey,

1 inch to 1 mile. Sheets: 34 and 54, district Karachi, 1906. Levels in Sind, 1 inch to 2 miles. Sheets: 25, districts Larkhana and Hyderabad, 1906; 30, district Karachi, 1906; 39, part of Kalat (Baluchistan), 1906; 40, parts of districts Sukkur, Upper Sind Frontier, Larkhana and Kalat (Baluchistan), 1906.—Burma Survey, 1 inch to 1 mile. Sheets: $84\frac{O}{2}$, part of districts Sagaing and Pakokku, 1906; $84\frac{O}{13}$ parts of districts Sagaing, Mandalay, and Kyauksi, 1906; $84\frac{N}{4}$, parts of districts Lower Chindwin and Sagaing, 1906; $84\frac{M}{10\ \&\ 14}$, parts of districts Katha and Shwebo, 1907; $94\frac{A}{5}$, parts of districts Yamethin and Southern Shan States, 1906; 192, part of district Shwebo, 1906; 263, parts of districts Hanthawaddy, Pegu, and Rangoon Town, 1903.—Central Provinces Survey, 1 inch to 1 mile. Sheets: 156, parts of districts Bilaspur, Mandla, and Balaghat, and Kawarda State, 1906; 233, parts of States Sirguja, Raigarh, and Odeypur and of district Bilaspur, 1906.—Eastern Bengal and Assam Survey, 1 inch to 1 mile. Sheets: 16, parts of districts Goalpara and Kamrup, 1906; 38, parts of districts Kamrup and Darrang, 1906; 70, parts of districts Sylhet and Cachar, 1907; 98, part of district Lakhimpur, 1906. Eastern Bengal and Assam: Dacca district, 1 inch to 8 miles, 1906; Mymensingh district, 1 inch to 4 miles, 1906.—Madras Survey, 1 inch to 1 mile. Sheets: 70, part of district Chitaldroog (Mysore), 1905. 74, part of district Tumkur (Mysore), 1905. 111 with part of 112, part of district Mysore (Mysore), 1900.—North-West Frontier Province, Peshawar district, 1 inch to 4 miles, 1906.—North-Eastern Trans-Frontier Survey, 1 inch to 8 miles. Sheets: 7, Sikkim and Bhutan, with parts of Nepal, Tibet, and adjacent British territory, 1906; 14, parts of districts Lakhimpur, Sibsagar, Naga Hills, Naga Tribes (Eastern Bengal and Assam), and of Singpho-Naga hills, 1905.—Punjab Survey, 1 inch to 1 mile. Sheets: 124, parts of district Multan and Bahawalpur State (Bari Doab), 1906; 298, parts of districts Rohtak and Delhi, 1906; 336, parts of district Ambala, Kalsia and Sirmur States (Punjab), districts Dehra Dun and Saharanpur (U.P.A. and O.), 1906.—United Provinces Survey, 1 inch to 1 mile. Sheets: 1, parts of district Ambala, Kalsia and Sirmur States (Punjab), districts Dehra Dun and Saharanpur (U.P.A. and O.), 1906; 129, parts of districts Kheri and Bahraich, 1906; 229, part of district Dehra Dun, 1906; 230, parts of districts Dehra Dun, Saharanpur, and Garhwal, 1906. Calcutta: Surveyor-General's Office. *Presented by the Secretary of State for India, through the India Office.*

Java. **Topographische Inrichting, The Hague.**

Topographische Kaart der Residentie Djokjakarta. Scale 1: 100,000 or 1 inch to 1·6 stat. mile. 4 sheets. Topographische Kaart der Residentie Soerabaja. Scale 1: 100,000 or 1 inch to 1·6 stat. mile. 4 sheets. The Hague: Topographische Inrichting, 1907.

AFRICA.

Egypt. **Survey Department, Cairo.**

Map of Egypt. Scale 1: 50,000 or 1·3 inch to 1 stat. mile. Sheets: I.–I. N.E., Cairo West; II.–II. N.E., Nawa; II.–III. N.E., Belbeis South; IV.–III. N.E., Abu Kebir; XIV.–I. S.W., Manfalut. Cairo: Survey Department, 1907. *Presented by the Director-General, Survey Department, Cairo.*

AMERICA.

British Columbia. **Wheeler.**

Karte eines Teiles des Selkirk-Gebirges in Britisch-Columbia. Nach der Karte von Arthur O. Wheeler im Massstab 1: 60,000. Scale 1: 300,000 or 1 inch to 4·7 stat. miles. *Petermanns Mitteilungen*, Jahrgang 1907, Tafel 13. Gotha: Justus Perthes, 1907. *Presented by the Publisher.*

Canada. **Dept. of the Interior, Ottawa.**

Sectional map of Canada. Scale 1: 190,080 or 1 inch to 3 stat. miles. Sheet 314, St. Ann, revised to May 18, 1907. Ottawa: Department of the Interior, Topographical Surveys Branch, 1907. *Presented by the Department of the Interior, Ottawa.*

GENERAL.

World. **Harmsworth.**

Harmsworth Atlas and Gazetteer. 500 maps and diagrams, and 105,000 references. Part 19. London: The Amalgamated Press, Ltd., 1907. *Price 7d. each part.*

This part contains the following maps: Nos. 59–60, Eastern Germany; 127–128. China and Tibet; 201–202, South-East Australia.

World. **Hickmann.**

Prof. A. L. Hickmann's Geographical Statistic Universal Pocket Atlas. London: Nilsson & Co., [1907]. *Price 5s. net. Presented by the Publisher.*

This is an English edition of the author's useful little "Universal Taschen-Atlas," with additional diagrams, maps and tables to bring it up to date, and to make it more serviceable to English readers. A commendable feature of the work is the system of representing graphically the statistics concerning population, religion, imports and exports, railways, etc., by ingeniously designed diagrams instead of giving tables of figures only. Altogether, with these, and the coats-of-arms and coins of different nations, in addition to the maps, this is a most instructive and interesting little atlas, and is remarkably cheap.

World. **Stieler.**

Neunten, von Grund aus neubearbeiteten und neugestochenen Auflage von Stielers Hand-Atlas, 100 Karten auf 200 Seiten mit 162 Nebenkarten in Kupferstich und einem alphabetischen Verzeichnis alter im Atlas verkommenden Namen (ungefähr 240,000 Namen enthaltend) herausgegeben von Justus Perthes' Geographischer Austalt in Gotha. Liefering 55 and 56. Gotha: Justus Perthes, 1907. *Price 60 pf. each part.*

This double part contains the following maps: No. 80, Australien, Bl. 4; No. 91, Vereinigte Staaten, Bl. 6; No. 100, Süd-Amerika, Bl. 6. With the publication of this part the present issue of this well-known atlas is brought to completion. The first part appeared in July, 1906, almost immediately after the last part of the previous edition, and the work has been published regularly in fortnightly intervals since that date. This is, strictly speaking, a re-issue of the last edition, with certain alterations and corrections, which in some respects have not been quite so thorough as might have been desired.

CHARTS.

Indian Ocean and Red Sea. **Meteorological Office.**

Monthly meteorological chart of the Indian ocean, north of 15° S. lat., and Red sea, August, 1907. London: Meteorological Office, 1907. *Price 6d. each. Presented by the Meteorological Office.*

Liverpool Bay. **Belam.**

Liverpool Bay. Surveyed by the Marine Surveyor, Commander Henry Belam, R.N., of the Mersey Docks and Harbour Board. Scale 1:36,000 or 1·7 inch to 1 stat. mile. Liverpool: Mersey Docks and Harbour Board. *Presented by H. G. E. Ashton, Esq., Assistant Marine Surveyor, Mersey Docks and Harbour Board.*

A new edition of this useful chart, with corrections and additional soundings to last year.

North Atlantic and Mediterranean. **Meteorological Office.**

Monthly meteorological chart of the North Atlantic and Mediterranean, August, 1907. London: Meteorological Office, 1907. *Price 6d. each. Presented by the Meteorological Office.*

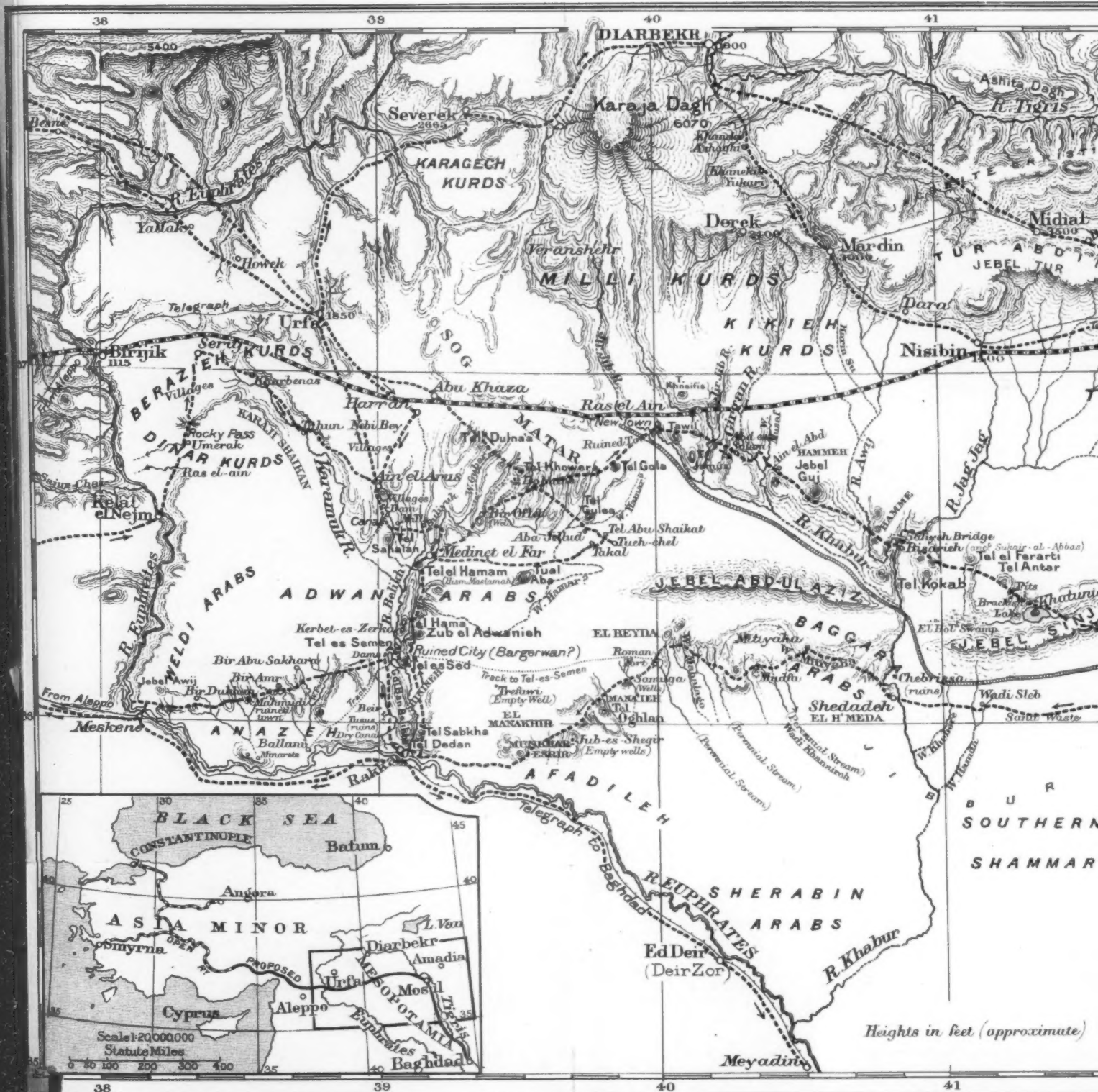
North Atlantic. **U.S. Hydrographic Office**

Pilot chart of the North Atlantic ocean, July, 1907. Washington: U.S. Hydrographic Office, 1907. *Presented by the U.S. Hydrographic Office.*

North Pacific. **U.S. Hydrographic Office.**

Pilot chart of the North Pacific ocean, August, 1907. Washington: U.S. Hydrographic Office, 1907. *Presented by the U.S. Hydrographic Office.*

N.B.—It would greatly add to the value of the collection of Photographs which has been established in the Map Room, if all the Fellows of the Society who have taken photographs during their travels, would forward copies of them to the Map Curator, by whom they will be acknowledged. Should the donor have purchased the photographs, it will be useful for reference if the name of the photographer and his address are given.



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